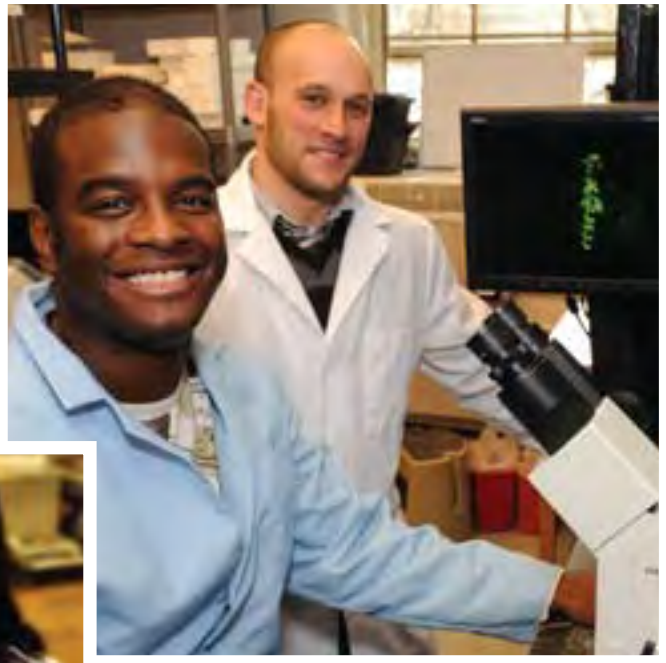
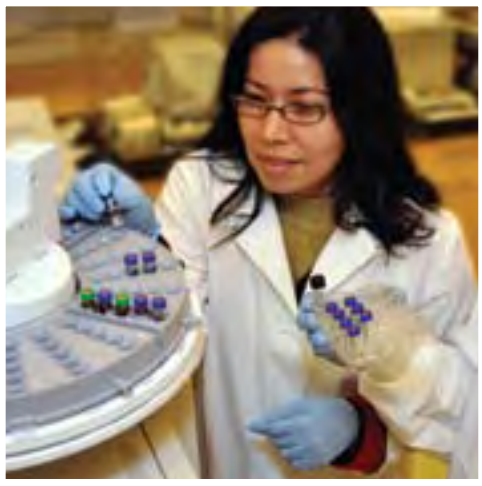
SEEDS

SEEDS: The OARDC Research Enhancement Competitive Grants Program

Report of Progress for Calendar Year 2009

Ohio Agricultural Research and Development Center





BRINGING KNOWLEDGE TO LIFE

THE OHIO STATE UNIVERSITY
OARDC

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For more information, visit our web site at:
http://www.oardc.ohio-state.edu/seeds

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Current and Past Industry Partners

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American Aggregates Corp.
American Berry Cooperative
American Coal Ashland Association
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Introduction

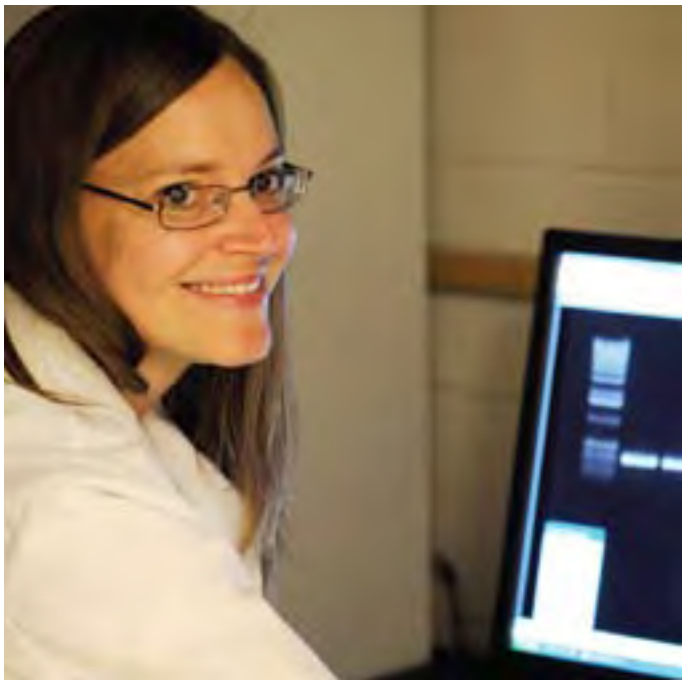
SEEDS: The OARDC Research Enhancement Competitive Grants Program

Despite the global financial hardships of the recent years, there have been several bright spots on the economy's horizon. One of the industries leading the nation's economic recovery is the agbioscience industry. Over the past five years, there has been significant growth in public awareness of the economic benefits of the agbiosciences. The innovations produced in the agbiosciences are driving new, highly visible economic opportunities for American states, and the State of Ohio has been an early mover in recognizing the economic development potential of the industry. As the nation's largest and most comprehensive agbioscience research center, the Ohio Agricultural Research and Development Center (OARDC) at The Ohio State University is a pioneer of cutting-edge innovation, establishing itself among the essential drivers of Ohio's economy.

The economic powerhouse that is Ohio's agbioscience industry is unparalleled. Agriculture is the most distributed industry across Ohio with operations in every county. It accounts for $94 billion, or 11%, of the state's total economic output and generates more than 984,000 Ohio jobs (15% of all employment in the state). No other economic engine comes close to making the kind of impact generated by agriculture, food, and the nursery and landscape industry. This massive industry employs one in every six Ohioans, and supports a diversified and dynamic economic sector that touches the lives of everyone in the state.

OARDC is the R&D hub for agbiosciences research in Ohio and serves as the state's signature research center for realizing progress in all significant aspects of the bio-based economy. OARDC's Ohio spending impacts generated 1,609 jobs; $156.3 million in economic output; $59.2 million in personal income for Ohio residents; and $5.5 million in state and local taxes. In a knowledge-driven economy intellectual property is perhaps the most valuable property that can be produced.

With the changing nature of economic and societal trends—as well as the impact of globalization—agriculture, food, and the green industry also depend on innovators and researchers to generate new processes or products and increasingly link with other industries to take on common challenges and opportunities in key areas such as environmental restoration or the development of bio-renewable sources of energy, fuel, and industrial goods. Opportunities abound in biobased industrial products, and agbiosciences holds the promise of stimulating



new economic growth across existing and new economic sectors throughout the state.

Addressing the differing challenges and vast opportunities of Ohio's largest industry is the ultimate goal of SEEDS: The Research Enhancement Competitive Grants Program. SEEDS promotes excellence in Ohio Agricultural Research and Development Center research, promoting research consistent with the mission and vision of OARDC, and encouraging connections across disciplines, with industry, and with other external partners.

Established in 1996 and supported by an appropriation from the Ohio General Assembly to OARDC, SEEDS: The Research Enhancement Competitive Grants Program is unique among U.S. state-assisted universities. In fostering high-quality research among scientists supported by OARDC and the College of Food, Agricultural, and Environmental Sciences, SEEDS enables those scientists to collect preliminary data needed to give them a competitive edge in national programs and provides them with leverage to attract industry support.

The signature research areas of the College of Food, Agricultural, and Environmental Sciences (CFAES) include: food security, production, and human health; environmental quality and sustainability; and advanced bioenergy and biobased products. By strategically investing in these signature areas for targeted research, discovery, innovation, and commercialization is accelerated.

Achieving preeminence in agbiosciences is "a clear and present" opportunity for The Ohio State University. OARDC's SEEDS program is just one of the many ways in which Ohio State's innovative research and development connects to industry and community on a global scale. Currently, Ohio State is ranked 19th among the nation's public universities and has been among the top 25 public research universities in each *U.S. News & World Report* ranking. According to the National Science Foundation's assessment of sponsored research expenditures, Ohio State ranks among the top 10 public research universities in the country.

OBJECTIVES

Seeds was created to encourage partnerships with industry and other stakeholders and to increase the competitiveness of OARDC/CFAES scientists in extramural grant programs. While these objectives remain the program's cornerstone, SEEDS has grown to include a total of seven objectives:

- Increase the competitiveness of scientists in extramural grant programs
- Encourage partnerships with industry and other stakeholders
- Encourage the development of interdisciplinary teams
- Encourage international collaborations
- Support the exploration of enterprises that are potentially new to Ohio
- Provide undergraduate students with research experience
- Provide graduate students with the opportunity to take part in the grant-writing/review process

By providing seed money to develop the necessary preliminary data for a strong grant application or by matching funds to leverage external funding, SEEDS has proved to be a valuable program for scientists in the College of Food, Agricultural, and Environmental Sciences. The SEEDS program looks forward to continued success and new partnerships with industry and other collaborators in Ohio and the world within the context of our global society.

PROGRAM ACHIEVEMENTS

- Overall, SEEDS has supported research projects at around $11,500,000 in all categories and has received close to $43,000,000 in matching and extramural funding—a return of about $4.00 for each dollar invested.
- Invested $2,307,098 in projects requiring matching funds, generating $4,129,075 in industry matches —a return of $2.00 on each dollar invested.
- Enabled scientists to establish collaborations with colleagues from Africa, Argentina, Australia, Belgium, Brazil, Chile, France, New Zealand, Norway, the Philippines, Switzerland, Taiwan, Uganda, and Zimbabwe.
- Applications have been made for nine U.S. patents using results of initial findings. Three patent applications have been granted and three licensing agreements have been obtained.
- A total of 687 peer-reviewed scientific manuscripts, abstracts, popular press articles, bulletins, and/or book chapters have been published and over 1,244 presentations have been made throughout the world.
- Seeds-supported graduate students have produced 42 doctoral dissertations and 72 masters' theses.

Achievements by Objectives

Objective 1—Increasing the competitiveness of scientists in extramural grant programs.

The Seed Grant Competition and the Agency External Competitions specifically address Objective 1. However, all the other competitions may result in additional funding from outside sources.

Of the 35 projects completed and reported in calendar year 2009, $284,864 was generated in extramural funding. Over the life of SEEDS, 315 projects have been completed and $42,146,433 has been generated extramurally.

Over the life of SEEDS, OARDC has invested $596,967 in matching funds for Agency External Grants, which generated $5,397,974 in extramural funding.

Objective 2—Encouraging partnerships with industry and other stakeholders.

The Matching and Industry Small grant competitions address Objective 2, and encourage the initiation of new projects in collaboration with industry, nonprofit foundations or other nontraditional sources of funding.

Of the fourteen grants requiring at least a dollar-for-dollar match and completed during calendar year 2009, OARDC provided a total of $375,880 while industry matched those dollars with $388,090.

For the life of the program, OARDC has provided $2,307,098 toward Matching and Industry Small Grants while industry matched these dollars with $4,129,075—a return of about $2.00 on each dollar invested.

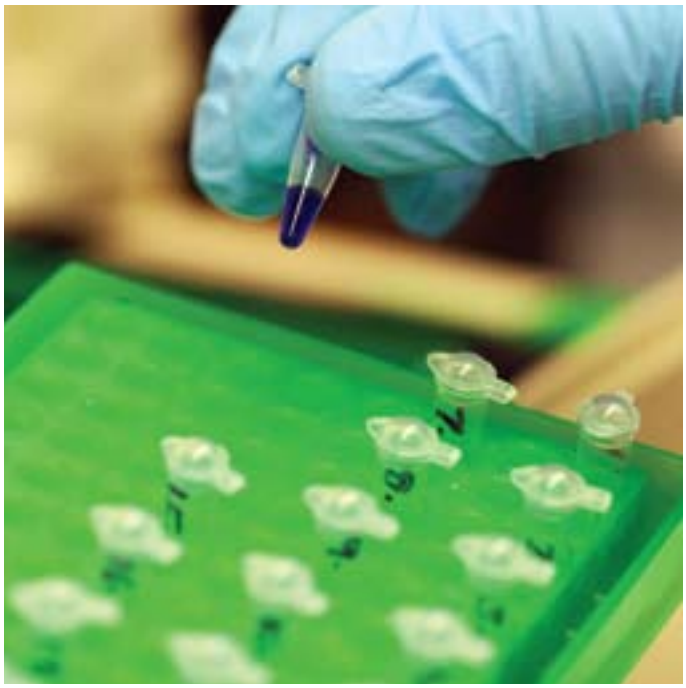
Objective 3—Encouraging the development of interdisciplinary teams.

The Interdisciplinary Competition stimulates new collaborations among scientists from different disciplines, departments and colleges. During calendar year 2009, eleven interdisciplinary teams completed projects. These teams reported receiving $5,975,991 in extramural funding.

Over the life of the program six colleges and 23 departments have participated in this category of competition with OARDC investing $5,136,988 and teams competing successfully and reporting $14,877,006 in extramural funding—a return of $2.90 on each dollar invested.

Objective 4—Encouraging international collaborations.

All competitions may have an international collaboration component, and international relationships are encouraged. OARDC scientists have collaborated with scientists from Africa, Argentina, Australia, Belgium, Brazil, Chile, France, Italy, New Zealand, Norway, the Philippines, Switzerland, Taiwan, Uganda, and Zimbabwe.



Objective 5—Support the exploration of enterprises that are potentially new to Ohio.

New Enterprises are considered to be crops, animals, products, goods, and services that currently are not produced for biological, physical, cultural, processing, economic, or social reasons. The New Enterprise Competition is designed to explore new enterprises and to eliminate the barriers that constrain existing ones.

The new Enterprise Competition has received 27 applications; eleven have been funded.

Funded projects include:

- New Commodity Enterprises in Ohio—Evaluation and Education
- Development of New Biological Products for Slug Control
- Direct Conversion of Agricultural Wastes to Electricity Using Rumen Microbes in Microbial Fuel Cells
- Domestication and Commercialization of Taraxacum—A New Crop to Fuel Ohio's Agricultural and Rubber Industry

Objective 6—Providing undergraduate students with research experience.

A total of 59 applications to the Director's Undergraduate Research Program have been received. Thirty-seven applicants have received awards.

The Director's Undergraduate Research Program provides undergraduate students with a professional grant-writing, research, and reporting experience. Projects are designed, submitted for review, and carried out with a faculty mentor. Once the project is completed, students take an independent studies class to write their research report in the form of a scientific journal article, using their faculty advisor as an editor. Some of these reports have been published. In addition, many students present their research at professional meetings and at competitions such as the Denman Undergraduate Research Forum, a university-wide program presented by the Ohio State University Office of Research and the University Honors and Scholars Center.

Objective 7—Providing graduate students with the opportunity to take part in the grant-writing/review process.

A total of 381 master's and doctoral students have submitted proposals in this competition. One hundred sixty projects have been awarded. The graduate competition is run exactly like a federal competition. Graduate students who received awards are asked to serve on a panel to review applications in the following year's competition. This experience provides students with an opportunity to develop their skills in grant-writing and reviewing—skills essential for them in their professional careers.

Interdisciplinary Team Competition

The Interdisciplinary Team Competition, funded at a maximum $100,000 level, is designed to stimulate new collaborative partnerships in multiple departments and colleges or build on existing programs of excellence. Interdisciplinary research provides expertise over several disciplines, bringing a more holistic approach to research questions and problems.

Steven Loerch

Tomato as a Functional Food:
Metabolic Engineering of Carotenoid Biosynthesis

Francis, David M., Horticulture and Crop Science
Grotewold, Erich, Plant Biology
Schwartz, Steven J., Food Science and Technology

David Francis

There is considerable public health interest in dietary carotenoids, a group of yellow to red pigments found in plants, to reduce chronic disease in developed nations. The carotenoids include beta-carotene or pro-vitamin A. Vitamin A deficiency in developing countries is a major concern for global health because a deficiency in the diet leads to blindness. According to WHO/UNICEF, the deficiency of vitamin A is a major health problem in developing countries with preschool children and women of reproductive age being the most affected. At the same time, populations consuming a diet with food rich in carotenoids have reduced risk of developing certain cancers, chronic diseases, macular degeneration, and radiation damage. These health effects are linked to lycopene, zeaxanthin, and lutein.

Tomato fruits are natural carotenoid factories that produce large amounts of beta-carotene and lycopene. Because of their positive link to human health, the antioxidant and pro-vitamin A carotenoid pigments are ideal candidates to engineer in crops. Through this study, scientists aimed to improve the amount and availability of bioactive carotenoids in tomatoes. Researchers targeted the alteration of the carotenoid pathway to address two specific hypotheses: first, that natural genetic variation in tomato could be used to create varieties with diverse carotenoid profiles; and, second, that two novel nutraceutical carotenoids—lutein and zeaxanthin—can be produced in tomato fruit.

During this study researchers had several specific objectives. The first set of objects was to use traditional plant breeding to develop tomato varieties with the appropriate carotenoid composition for the metabolic engineering of lutein and zeaxanthin; to assess tomatoes with diverse carotenoid profiles for their potential as a functional food; to establish transgenic tomato plants expressing the genes necessary for the biosynthesis of zeaxanthin and lutein in the tomato fruit; and finally to determine the levels of carotenoids and related metabolites in tomato fruit engineered to produce lutein and zeaxanthin.

Scientists cloned a fruit specific promoter (on-off switch) and have linked it to a beta-carotene hydroxylase enzyme. The enzyme is a candidate for the protein responsible for converting Delta-carotene into lutein and beta-carotene into zeaxanthin. Researchers generated transgenic plants in three different genetic backgrounds: a normal tomato, a high beta-carotene tomato, and a high delta-carotene tomato.

First generation transgenic plants containing the hydroxylase enzyme under regulation of the fruit specific promoters were analyzed for carotenoid content. As expected, no zeaxanthin was detected in the unmodified control plants, the genetically modified normal plants, nor the genetically modified high delta-carotene plants. The genetically modified high beta-carotene plants produced detectable zeaxanthin. Lutein levels were increased two-fold in the genetically modified high delta-carotene plants.

Lutein was observed in all transgenic tomato varieties tested. Also, the delta-carotene tomatoes contain lutein at levels roughly 5–10x greater than the T5 "control" tomatoes and two times greater than the high delta-carotene control tomatoes. Zeaxanthin was also detected in the beta-carotene tomatoes, albeit at extremely low levels.

These experiments establish proof of concept demonstrating that novel carotenoids can be increased by expressing enzymes in the fruit that modify existing carotenoid substrates.

Economics and Neuroscience:
Using Functional Magnetic Resonance Imaging and Experimental Economics to Understand Behavioral Response to Economic Risk

Roe, Brian E., Agricultural, Environmental, and Development Economics
Haab, Tim, Agricultural, Environmental, and Development Economics
Beversorf, David Q., Neurology

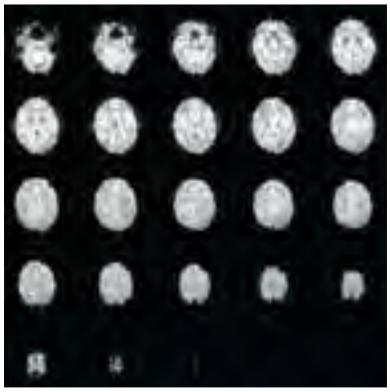
Risk is a fundamental component of agricultural and environmental systems. Choices towards production and consumption of agricultural and environmental commodities are intimately shaped by an individual's attitudes toward risk. Research on human risk attitudes prior to the commencement of this research focused mainly on correlating individual differences in risk attitudes to differences in individual wealth, income, or demographic characteristics. This study was among the first to seek more fundamental reasons for differences in risk attitudes, specifically the first to see if individual differences in the brain's neural responses and genetics were correlated to differences in risk attitudes and risky behavior. Understanding these differences will ultimately enable researchers to develop a better understanding of the biological infrastructure that gives rise to economic decisions involving risk.

The approach to this study involved measuring human subjects' attitudes toward risk in face-to-face sessions involving economics experiments where subjects' decisions concerning risk affected their take-home pay. Investigators also collected other measurements of risk attitudes, risk perception, and reports of past risky behavior using several survey instruments. All subjects were then invited to provide a blood sample to be used for genetic analysis and a subset of subjects were invited to participate in a brain imaging experiment. Statistical techniques were then used to correlate individual subjects' risk attitudes to several sources of genetic variation.

While major data analyses continue, scientists can report several findings. First, it was found that recruitment into studies that involve brain imaging and blood samples can influence the type of people who agree to participate. Specifically those who dislike risk are less likely to participate in experiments featuring methods such as brain imaging and blood samples. Furthermore, initial analysis suggests that risk attitudes may be correlated to a source of genetic variation in the nicotine system. The nicotine system helps control how dopamine moves through the brain, and dopamine is a naturally occurring chemical in the brain that is often the target of recreational drugs. Such a finding is unique in the literature, but not totally unexpected given the addictive nature of nicotine and given that addictive personalities have often been linked to risky decision-making. However, it does open up new avenues of thinking concerning the systems of the brain that must be considered when trying to uncover the biology of human behavior in the face of risk.

Only a fraction of the genetic analysis has been completed with more than 200 subjects' genetic material still to be analyzed and additional information from the surveys to be processed and analyzed; including fully analyzing reports of past drug and alcohol use and risk perceptions. This analysis will lead to additional manuscripts and ideas for funding. Researchers will seek additional funding to replicate the findings that are already established and to broaden the work into other realms of decision-making such as obesity, which has been linked to both impulsive and risky decision-making.

Brian Roe



Bio-electricity from Agricultural Lignocellulose Wastes

Christy, Ann D., Food, Agricultural and Biological Engineering
Dehority, Burk A., Animal Sciences
Tuovinen, Olli H., Microbiology

Energy demand is increasing across the globe while conventional energy sources such as oil and coal are scarcer and more costly. Renewable and sustainable technologies become attractive alternatives as U.S. society considers long-term energy security as a nation. Bio-energy sources such as biodiesel and bio-ethanol may be part of the solution, but in both cases there are inefficiencies to be overcome in the process of chemically or biologically converting biomass (e.g., corn, soybeans, switchgrass, etc.) into a liquid or gaseous fuel and then burning that fuel in a combustion engine to get useful work from the biomass. This project explored a new technology, the microbial fuel cell, which converts biomass directly into useful energy in the form of bio-electricity without needing an intermediate combustion step.

Microbial fuel cells (MFCs) are bio-electro-chemical reactors in which microorganisms mediate the direct conversion of chemical energy stored in organic compounds (from sugars to wastes) into bio-electricity. MFCs work by employing the natural biological process of the microbes; electron transport system to generate renewable energy for human use. In MFCs, bacteria generate electricity by oxidizing organic compounds and transferring the released electrons to an anode electrode. They do not currently produce as much energy as the more common hydrogen fuel cell, but they do not have the disadvantages of the hydrogen fuel cell's high cost of required catalysts, corrosive nature of their electrolytes, and the high temperatures required for operation.

Ann Christy

This MFC research has resulted in several new discoveries. The microorganisms living in the rumen (first stomach) of a cow were found to be able to produce sustainable electrical power in MFCs when fed a regular "diet" of cellulose. Cellulosic biomass, including solid waste products of agricultural and industrial activities, is one of the most abundant renewable sources of energy on earth. However, these compounds are highly recalcitrant and hard to break down. Cows and other ruminants, such as sheep, goats, camels, and llamas, are uniquely adapted to being able to use cellulosic materials (such as grass, hay, silage) as food due to the synergistic relationship between the animal host and its rumen microorganisms.

The electrical power output in these MFCs was sustained for over two months with periodic cellulose addition. The results demonstrated that electricity can be generated from cellulose by using rumen microorganisms as biocatalysts. It was found that the microbial communities differed when different substrates were used in the MFCs; likewise, the anode-attached and the free-floating microbes were shown to be different within the same MFC. This study also showed that the external electrical circuit resistance significantly affects the bacterial diversity and power output of MFCs. Higher power output and greater efficiencies were achieved in MFCs with lower external resistance. The microbial populations themselves also varied at the various external resistances.

Furthermore, this study showed that methane formation competes with electricity generation at the early stages of MFC operation but that operating conditions suppress methanogenic activity over time. Further understanding of the microbial communities, interspecies interactions, and processes involved in electricity generation are essential to more effectively design and control cellulose-fed MFCs for enhanced performance. In addition, technical and biological optimization is needed to maximize power output in cellulose-based MFCs. Further research in this area may bring scientists another step closer to finding sustainable energy alternatives.

Nitrogen Cycling and Kinetics in Manure, Compost, and Soil

Dick, Warren A., School of Environment and Natural Resources
Michel, Frederick C., Food, Agricultural and Biological Engineering
Weiss, William P., Animal Sciences

Nitrogen is the most limiting nutrient for most crop production systems. Farmers are continually evaluating ways to help them maintain high crop yields while minimizing nitrogen fertilizer expenses. One strategy is to use the least expensive source of nitrogen whenever possible and this could be as close as the nearest dairy, poultry, or swine barn. Manure is rich in nutrients, including nitrogen, and the amount of collectible manure on farms in the United States is approximately 51 million tons (dry weight) a year. Even though manure is a valuable resource, it can also contribute to water and air pollution. A conservative estimate is that 20–30% of the nitrogen contained in manure is lost during collection, treatment, and application. This represents about 230 thousand tons of nitrogen with an agronomic value of more than $170 million. Tremendous amounts of energy are needed to replace, by use of fertilizers, the nitrogen in manure that is lost. This reduces overall agricultural efficiency and increases costs.

Warren Dick

Gypsum is a quality source of both calcium and sulfur for yield enhancement of root crops, for reclamation of sodic soils, for improving air and water infiltration rates into soil by inhibiting or delaying surface seal formation, and for improving deep rooting by crops so that water and nutrient uptake are dramatically improved. The source of gypsum has traditionally been from geologic deposits that are mined. More recently, gypsum has been obtained as a high-quality product derived from the scrubbing process to remove sulfur dioxide from flue gases when coal is burned as an energy source. This gypsum, called flue gas desulfurization (FGD) gypsum, is a clean source of gypsum with excellent crystalline properties.

Researchers theorized that mixing FGD gypsum with animal manures prior to composting would result in less ammonia release. This would conserve nitrogen and translate into fewer odors. The final product would contain humic matter, gypsum, and gypsum-derived minerals that could benefit many soils. To test this hypothesis an experiment was conducted using small 4-L vessels containing 1.1 kg of dairy manure mixed with FGD gypsum and composting for 18 days. The amount of nitrogen released as ammonia gas was trapped in an acid solution and quantified.

Gypsum addition affected the initial compost moisture content, volatile solids content, nitrate content, and carbon: nitrogen ratio. Rates of gypsum above the 6% of the total starting material did not provide additional benefits in terms of conservation of nitrogen in the final compost product. However, more studies using various starting materials with different carbon: nitrogen ratios are needed to confirm the best gypsum rate to use.

This study showed that combining nitrogen-rich organic materials, such as dairy manure, with by-product gypsum can help control odors and air pollution associated with release of ammonia and conserve more total N in the final compost product. This effect may be enhanced if the carbon: nitrogen ratio of the initial composting mix is adjusted to values of about 30 when using nitrogen-rich feedstocks. The gypsum in the final product can also provide benefits to soils.

Tests have been initiated to determine whether using FGD gypsum as a sulfur fertilizer will increase nitrogen fertilizer use efficiency in the field. If this is the case, farmers could maintain or increase crop yields without increasing nitrogen fertilizer rates. A workshop titled Agricultural Uses of FGD Gypsum was organized with support from USDA, USEPA, American Coal Ash Association (ACAA), and the Electric Power Research Institute (EPRI). The workshop was held in Indianapolis, November 17–19, 2009.

Farm Animal Welfare in Ohio:
Assessing Public Concern and Implications for the Food Animal Industry

Lobao, Linda M., Human and Community Resource Development
Coleman, Grahame, Animal Sciences
Eastridge, Maurice L., Animal Sciences
Hemsworth, Paul, Animal Sciences
Sharp, Jeff S., Human and Community Resource Development
St. Pierre, Norman, Animal Sciences

The welfare of farm animals concerns animal scientists, social scientists, the food industry, and the public at large. Producers are facing a new regulatory environment as quick food service chains and more recently state governments have scrutinized the treatment of farm animals. However, little is known about the U.S. population's views and behaviors regarding farm animal welfare. The purpose of this project was to fill this research gap. The project involved focus groups with the Ohio public and producers to develop a survey instrument to assess public attitudes and their determinants. The survey was conducted using a random sample of the Ohio population with a comparative smaller nationwide sample. The project provides the most comprehensive, detailed information on public attitudes and behavior regarding animal welfare across Ohio and the U.S. population to date.

This study evaluates the factors associated with public attitudes and behavior about farm animal welfare. The focus is on the characteristics of individuals who manifest greater or lesser concern with farm animal welfare. To accomplish these goals, a survey was mailed to 4,800 individuals to collect these data: 3,000 were Ohio residents and 1,800 were residents of other states that allow for comparison with the Ohio findings. The response rate for Ohio was 35% (976 respondents), with a 27% response rate from other states.

There were two major results. First, investigators developed detailed measures of public concerns related to farm animal welfare, using factor analysis, a statistical technique that groups variables into different sets of domains. These sets of attitudes/beliefs represent the most comprehensive yet developed from quantitative research on the U.S. population.

Researchers found that consumer concerns cluster into the following eight dimensions: (1) concern with the animals' physical well-being (e.g., need for space, daylight); (2) concern with welfare-adequacy (e.g., beliefs about the degree to which producers protect animals' welfare); (3) care for animals in intensive settings (e.g., beliefs about how animals are treated in

Linda Lobao

large livestock enterprises); (4) care for animals in family farms (beliefs about how family farmers treat animals); (5) respect for the general quality of life of animals; (6) views that human life is more important than animals; (7) belief that animals should be used for humans' utilitarian purposes; and (8) animal welfare-directed consumer behavior. The eight sets of variables demonstrate that the public's concerns are not expressed in a single area but consist of multiple sub-issues.

Second, scientists asked what characteristics of individuals are related to the degree of concern with animal welfare. Researchers evaluated the predictive performance of the following types of determinants: social status; rural-urban residence; social-political concerns; and knowledge about farm animal production. To evaluate these predictive factors, researchers used multiple regression analyses. Out of all these, the major determinants of greater concern that appear consistently across models are: gender (women); urban residence; greater concern about the environment; and less direct contact with farmers. These results demonstrate that concern with farm animal well-being tends to be related to consumers' demographic characteristics and non-agricultural belief systems and thus will be little affected by educational outreach on agricultural practices. Further, as urbanization and concern with the environment increases, we might expect concern with farm animal well-being to grow among the public.

The research team is preparing a series of articles to submit to journals such as the *Journal of Animal Sciences* and *Rural Sociology*.

Effects of Low Dietary Vitamin A on Animal Health and Quality and Nutritional Characteristics of Beef

Loerch, Steven C., Animal Sciences
Schwartz, Steven J., Food Science and Technology
Saif, Linda J., Food Animal Health Research Program
Fluharty, Francis L., Animal Sciences

Beef production is evolving to meet consumer demands for a higher quality product in terms of both palatability, or taste, and nutrient composition. Palatability is associated with increasing the amount of fat deposited intramuscularly, or marbling. Nutrient composition of beef can be improved by increasing the concentration of special types of fat in the meat. These fats, called conjugated linoleic acids (CLA) improve human health by reducing risk of heart disease and cancer. Feeding low vitamin A diets to cattle may be a management strategy to achieve these goals.

This project investigated the effectiveness of feeding low vitamin A diets to increase marbling and CLA content in beef. Scientists theorized that an optimum intake of vitamin A would enhance desirable beef characteristics without detrimental effects on animal health.

The site of fat deposition in growing cattle influences beef carcass value. Fat deposited inside the muscle, or marbling, improves carcass value because marbling enhances meat palatability. Whereas, fat deposited on the outside of the muscle reduces carcass value because the fat must be trimmed before selling the beef to consumers. Vitamin A inhibits formation and development of fat cells. The implications for the industry by addressing this question are of great magnitude. The use of lower vitamin A diets to increase marbling can be easily adopted. Furthermore, confirming the effects of low vitamin A diets on marbling under diverse feeding conditions may provide evidence that this is an effective strategy to change the site of fat deposition within the carcass and therefore improve the profitability of beef production.

Pat Tirabasso

Increased consumer awareness of the nutritional and health aspects of food composition has stimulated research to manipulate the type of fat contained in animal products. However, to achieve these goals, animal welfare cannot be sacrificed. It is critical that optimum dietary vitamin A levels needed to improve meat characteristics do not result in a vitamin A deficiency in the cattle. A thorough investigation of effects of low vitamin A diets on animal health was a critical objective of this proposal.

To investigate these opportunities to improve value of beef, researchers first determined beta-carotene content of feedstuffs now commonly fed to beef cattle in the Midwest. Beta-carotene is converted to vitamin A by the animal and therefore, serves as a dietary source of vitamin A. Investigators also determined the effect of corn source and vitamin A intake on the fat cells in beef, the site of fat deposition, the chemical composition of the fat, and the effects of these diets on the health and immunity of the beef cattle.

Scientists discovered that common cattle feeds used in the Midwestern United States contain about half of the recommended vitamin A equivalents. However, the current recommendation for vitamin A for cattle is higher than necessary. Researchers found that low vitamin A diets did not reduce cattle performance measures, such as growth rate or feed intake. Also, no negative effects of low vitamin A diets on cattle health were observed. In four cattle experiments, scientists discovered that low vitamin A diets improved marbling without affecting the amount of fat on the outside of the muscles. This effect increased the value of each carcass by more than $30.

This research will be continued to further develop our understanding of how vitamin A nutrition can be used to improve beef quality and value. Scientists will investigate the importance of the timing and duration of removal of vitamin A supplementation. Plans are also being made to investigate the role of vitamin D in this process.

Enhancing Agricultural and Food Safety Through Risk Analysis

Doohan, Douglas, Horticulture and Crop Science
Hooker, Neal H., Agricultural, Environmental, and Development Economics
LeJeune, Jeffrey T., Food Animal Health Research Program
Tucker, Mark A., Human and Community Resource Development

Certain agricultural risks such as food-borne human pathogens, water contamination, and invasive species threaten not only the farmer but also society in general. More than ever it is critical that university outreach and extension be optimized so that farmers not only receive training but actually adopt practices that mitigate risks.

Risk analysis is a potential modification to traditional extension that has proven successful in promoting more complete adoption of preventive practices that impact a wide range of risks in many sectors. Agricultural scientists routinely use risk analysis to assess the likelihood of various outcomes for stakeholders and select different management options to minimize the risks. However, agricultural scientists have not embraced the theory and practice of risk communication—an integral component of a complete risk analysis program. Risk communication begins at the onset of a risk analysis program and continues throughout the life of the project by actively engaging both stakeholders and scientists in defining the issues, designing and analyzing risk assessments, and selecting and evaluating risk management options.

Douglas Doohan

For this project researchers focused on improving risk communication related to the following case studies: the up-and-coming weed of Ohio farm fields, apple of Peru (*Nicandra physalodes*); and the therapeutic use of antibiotics in cull dairy cattle. Scientists theorized that improving risk communication about invasive species and food safety would require detailed knowledge about how farmers defined the problems, reacted to the issues, gathered relevant information, assessed risks and benefits, and made decisions. Investigators chose a mental models approach to gathering the relevant data from samples of row-crop farmers and livestock veterinarians. An individual's mental model can be thought of as a complex web of deeply held, often subconscious beliefs that influences how an individual receives and perceives new information. For each case study, an expert model was developed by interviewing subject-matter specialists from across the United States. Key findings from the expert models were used to construct interview protocols that were administered to groups of farmers and veterinarians. Twelve university weed scientists were interviewed to develop the expert weed model.

Twenty percent of the farmers believed that weeds could not be prevented, undergirded by a deeper conviction that introduction and spread of weeds by wind, water, and wildlife was inevitable. Nearly all farmers expressed a very strong preference for weed control with herbicides. This preference may contribute to their reluctance to integrate alternative management strategies.

By identifying several of the motivational and cognitive processes that underlie farmer decision-making, we now have some preliminary insight into designing more effective education and communication efforts for the adoption of integrated weed management and resistance management. Future plans for this research include a follow-up representative survey of row-crop farmers in Ohio and Indiana designed to validate the findings from the mental models research, as well as an extension of the previous study to address weed management on organic farms.

The Nature of the Association of *Pantoea stewartii*, the Causative Agent of Stewart's Bacterial Wilt of Corn, with its Flea Beetle Vector, *Chaetocnema pulicularia*

Hogenhout, Saskia A., Entomology
Coplin, David L., Plant Pathology
Meulia, Tea, Molecular and Cellular Imaging Center
Pratt, Richard C., Horticulture and Crop Science
Redinbaugh, M., USDA/ARS-Plant Pathology

Infectious diseases of corn can cause devastating yield losses and make grain unfit for consumption. Corn seed and grain is continually moved around the world through commerce. Many diseases and pests are strictly regulated to prevent the spread of diseases but quarantine laws also may restrict the export of grain or seed stocks to many countries. Some pathogens are also transmitted from region to region by insect vectors. Understanding how pathogens and their hosts interact can give scientists valuable insight for development of ways to reduce the insect transmission and subsequent economic impact of disease-causing microbes.

The bacterium *Pantoea stewartii* (Pnss) causes a pervasive disease of sweet corn and field corn known as Stewart's Bacterial Wilt and Leaf Blight, respectively. The pathogen, a bacterium, depends on the corn flea beetle, *Chaetocnema pulicularia* to reach its host in the field. Pnss is believed to be carried in the alimentary tract of flea beetles and it has been assumed that it remains there while adult flea beetles overwinter in the soil. However, no study has ever conclusively determined whether or not the bacteria really overwinters in the insect or instead survives in perennial grasses. Therefore, a clearer understanding of the interaction of Pnss with is vector will be needed to develop better management procedures.

Research was undertaken to determine which organs and tissues of the insect are colonized by the pathogen. Specifically, we sought to determine whether Pnss persisted in flea beetle guts over a ten-day period, and where within the bacterial gut the bacteria were located. Direct tests were used for marked bacteria and microscopic investigations of infested beetles to answer these questions.

Many bacterial pathogens have a molecular tool that enables them to secrete proteins directly into host cells. This tool is a needle-like protein called an injectisome or pilus and it is part of a secretion system called a type III secretion system or T3SS.

(left to right) Richard Pratt, Peg Redinbaugh, Valdir Correa

When we mutated a gene that is required for making the animal-type T3SS in Stewart's wilt bacteria, the ability of the bacteria to persist in the insect gut was reduced and so was the ability of the insect to transmit the pathogen to corn. Persistence of Pnss in and transmission of Pnss by the beetles were restored complementing the mutation.

These results demonstrate that the animal- and plant-type T3SS in Stewart's wilt bacteria have different and essential roles in adapting the bacteria to its insect and corn hosts, and suggests similar mechanisms may be important in other bacteria that carry the two types of T3SS. These results will be published in the near future.

Genetic Resources for Grafted Vegetable Production

Francis, David M., Horticulture and Crop Science
Miller, Sally A., Plant Pathology
Kleinhenz, Matthew D., Horticulture and Crop Science
Blaine, Thomas W., OSU Extension

Grafted vegetables are emerging as an important component of production systems all over the globe. The systems range from sophisticated high-input hydroponic greenhouses in North America and Europe to subsistence agriculture in Asia. Investigators tested whether this technology might have an application to soil-based production including organic and high-tunnel systems in Ohio. Rootstocks were evaluated based on their potential to increase resistance to soil-borne disease, increase scion vigor, and increase scion yield. The project contained technology transfer goals, including empowering Ohio growers and nurserymen to graft their own transplants; and development goals, including breeding new rootstocks.

David Francis

Vegetable crops produced under organic systems often produce less relative to conventional systems due to nutrient availability and disease pressure. Researchers addressed whether growing tomatoes on root stocks might increase productivity. Scientists tested 35 rootstocks (RS), including commercial checks and experimental varieties developed in Ohio. The specific objectives of the study were to test the feasibility of using

RS in soil-based production systems; quantify the effects of grafting to RS on yield and quality; test the hypothesis that genetic distance between parents would predict RS vigor and performance; and finally to provide growers with research-based information relative to grafting.

Significant differences were observed between RS for seed germination and percent success of grafts. In the field, location and replicate within location were highly significant for both total yield and marketable yield. Significant genetic effects for total yield and marketable yield were detected. Only a few RS proved better than the ungrafted or self-grafted controls and several performed worse. Where Southern Blight was present, there were clear advantages to using RS, and several experimental RS appear tolerant to the disease. Despite differences between locations, several RS emerged as high performers across locations. The results suggested several points where selection might be implemented in a RS breeding program.

Investigators shared information relative to grafting techniques, grafting sanitation, and the performance of grafted tomatoes with over 900 growers, Extension educators, and university personnel through twenty-nine Extension presentations, demonstrations, and hands-on workshops. A project web-page (www.oardc.ohio-state.edu/graftingtomato/) and how-to videos (www.youtube.com/user/TomatoLab) are reaching more than 600 people per month.

Investment from the OARDC Research Enhancement Competitive Grants Program was instrumental in helping the research team obtain further funding from the USDA Integrated Organic Program. This subsequent project has allowed researchers to expand the scope of the project. Investigators hope to obtain sufficient data to meet the Crop Variety Release and Distribution Committee criteria for release of a new rootstock variety.

Implications of Climate Change for Agricultural Pest Management

Cardina, John, Horticulture and Crop Science
Herms, Daniel A., Entomology
Moore, Richard H., Human and Community Resource Development
Taylor, R.A.J., Entomology

The thermal requirements of crops and insect pests differ significantly; their differential thermal requirements will govern how climate change impacts pest management needs and practices. To investigate the impact of climate change on pest management and the implications for farming communities, scientists have connected EPIC, a field-scale crop management model, with a temperature-driven model of insect population development (GILSM). EPIC was used to model the corn and soybean rotation common in the Midwest, and GILSM was programmed to model the growth of nine insect pests of corn and/or soybeans.

Output from the model system was input to a geographic information system covering the eight-state corn-belt (Indiana, Illinois, Iowa, Kansas, Kentucky, Missouri, Nebraska, and Ohio). The models were driven using GFDL-CM2 climate scenario data developed for the period 1901–2100 as part of NOA and IPCC investigations of global climate change. Over the past 100 years, crop productivity has increased several fold as a result of improved cultivation methods, fertilizers and pesticides, and plant breeding. In order to remove the confounding of changes in technology and possible climate

R.A.J. Taylor

change over the past century and unknown changes to come in the next century, a standard crop production protocol was used from 1901–2100. Using the crop production practices used most commonly in 2000 (the midpoint of the period), EPIC/GILSM was run for four 50-year periods (1901–1950, 1951–2000, 2001–2050 and 2051–2100) and the changes in crop yield and insect abundance were examined between periods. Nine insect pests found throughout the region were modeled to examine the range of likely responses of insect pests to climate change and the possible change in crop protection needs over the next 100 years.

As expected, the model predicted little or no change between the first and second periods. For most species, change was maximum in the third period and less during the fourth period. In every case, the isoclines for pest population density and crop productivity moved northwards, but at different rates, resulting in the isoclines for crop damage increasing as they moved northward. In two cases, the pest abundance declined locally even as productivity increased, resulting in a net increase in productivity. No allowance was made for changes in agronomic practices or improvements in breeding pest resistance, both of which have helped to improve productivity over the past century. Now that scientists have a good understanding of the implications for changes in herbivory resulting from climate change, investigators will be seeking outside funding to investigate the more difficult topic of how warming could influence the differential effect of warming on crop plants and weed competitors.

(left to right) Martha Belury, Michelle Asp, Kara Kliewer

Matching and Industry Small Grant Competitions

The Matching and Industry Small Grant Competitions are specifically designed to develop partnerships with private industry and non-profit foundations. Industry Small Grants provide up to $6,000 from the SEEDS program while Matching Grants provide up to $50,000. Investigators are required to obtain at least a dollar-for-dollar match from industry for both of these competitions.

Robert Hansen (back) and Mike Sciarini

Josh Bomser

Development of a State-of-the-Art Computer-Controlled Nutrient Delivery System for Container-Grown Landscape Nursery Crop Research

Hansen, Robert C., Food, Agricultural and Biological Engineering
Herms, Daniel A., Entomology

In the year 2000, dialog began with Argus Control Systems Ltd. (Argus) about providing accurate nutrient delivery to small-scale landscape nursery and greenhouse crops along with a full-featured data acquisition and control system. Since that time, Argus has invested over $250,000.00 in the design and development of a high accuracy Nutrient Delivery System. An OARDC Small Industry Competitive Grant and a continued relationship between Argus and the Ohio Agricultural Research and Development Center (OARDC) through the Department of Food, Agricultural, and Biological Engineering led to the delivery of a new Titan Greenhouse Control System in December 2006 for Beta testing. The Argus Titan System included monitoring, alarms, data recording, and remote control that were fully integrated with the Nutrient Delivery System.

The objective of this project was to design and construct a state-of-the-art, computer-controlled irrigation and fertigation system capable of delivering specified recipes of nitrogen, phosphorus, potassium, water, and pH modification to container-grown nursery crops for the purpose of studying physiological responses of woody plants to critically defined water and nutrient treatments. In addition, the fertigation system was to support engineering research related to the performance and precision of automated systems designed for water and nutrient delivery. The landscape nursery industry continues to take advantage of new technology that improves labor efficiency, production efficiency, and environmental acceptability.

The primary challenge was being able to accurately deliver specified recipes in low flow rates required for small research plots where a municipal water supply is used as the source water for the system. The equipment was to be designed to provide water and nutrients for designed experiments involving landscape nursery plants grown outdoors in containers on a gravel bed or in a greenhouse. Nutrients and water were to be delivered to as few as fifteen or as many as fifty container-grown plants by dripping nutrient solutions into growing media that sustains the plants. Recipes for major nutrient concentrations such as nitrogen, phosphorus, and potassium were to be formulated from common stock solutions such as calcium nitrate, potassium nitrate, and mono ammonium phosphate based on specifications entered into a computer using custom designed software.

Robert Hansen (left) and Daniel Herms

Beta testing will continue at OARDC in collaboration with Argus Control Systems, Ltd. Therefore, modifications to the software and hardware will frequently be implemented that will lead to improvements in the precision of individual nutrient delivery to crops. Purge and prime events have to function properly between queued treatments in order for nutrients to be delivered on target. The modification and control of pH is also ongoing and scheduled for improvement. The alkalinity of solutions is impacted by the quantity of nutrients added to the source water. Thus, pH control depends on the predictability of nutrient blending and the consistency of the source water itself. Laboratory analyses of the concentrations of individual nutrients in the solutions will continue so delivery accuracy can be confirmed.

Microbial Communities Associated with Soils and Weed Seeds

Cardina, John, Horticulture and Crop Science
Michel, Frederick C., Food, Agricultural and Biological Engineering

Weeds and weed control are among the most significant economic and environmental concerns in agriculture. The struggle to manage weeds is a major obstacle to adoption of organic farming methods. In some vegetable crops, Ohio farmers commonly spend $600 per acre in labor costs to control weeds. Yet in spite of weed management efforts, weeds still reduce crop yields about 10 to 30%. There is considerable public concern about the environmental effects of herbicide use as well as soil lost to erosion due to cultivation for weed control. Therefore, any new approach researchers can take to manage weeds without additional environmental degradation is worth pursuing.

The project addressed the weed problem by focusing on the thousands of weed seeds that live in soil. The seeds in soil are surrounded by microorganisms, including some that are known to decay plant material. What remains a mystery is how those microorganisms affect weed seed survival and whether soil can be managed in a way that will make those microorganisms more active in weed seed colonization and decay.

Researchers asked whether a farmer could use soil microorganisms to kill weed seeds by increasing the activity of microbes that feed on seeds. If a soil has more different kinds of microorganisms, like fungi and bacteria, then maybe some of them will attack weed seeds and destroy their ability to survive and germinate. Investigators theorized whether or not weed seed survival could be reduced if farmers worked to increase the organic matter of their soil over several years. To examine this theory, scientists examined the microbial properties and weed seed survival in soils that have been in an organic rotation for over 15 years and compared them with soil in a standard crop rotation. Researchers studied soil nutrients, soil organic matter, and the genetic fingerprint of microbes in the two soils, along with the weed seeds that survive in them. Giant ragweed seeds were mixed into the soils for several weeks and the microbes that colonized the seeds were then examined.

Scientists found large differences in the microbial activity in the soils, and clear differences in the community of microorganisms that inhabit them. The organic soil had more diverse microbial communities, higher levels of organic matter, and different components of organic matter compared to the standard soil.

The results suggest that even though the microbial communities were different in the two soils, researchers could not prove that the impact of those organisms on weed seeds was different. There are many reasons. Most soil microorganisms are generalists, meaning they colonize whatever organic matter is available to them. The results suggest that soils with a different history did not have microorganisms that differ in their ability to attack weed seeds.

This study was the investigators' first attempt to understand the interaction of soil microorganisms and weed seed decay. There are many more variables that need to be tested, including other soil amendments. Weed seed-coats are very well-protected by chemicals that ward off fungi and bacteria. It is possible that microbial communities could be developed that can overcome these protectant chemicals to leave the weed seeds vulnerable to attack from other microbes. Further studies are already under way to examine the chemical composition of seed-coats and the behavior of microbial communities that colonize the exterior surface of weed seeds.

John Cardina

Evaluation of Dormant Applications of Phosphite Fungicides Combined with the Bark Penetrating Adjuvant Pentra-Bark® for Early Season Control of Apple Scab

Ellis, Michael A., Plant Pathology

Venturia inaequalis is the fungus that causes apple scab. Apple scab is the most serious and economically important disease of apple crops throughout the Midwest and Northeast United States. When apple scab first develops it is characterized by soft, velvety, olive-green spots. As the infection progresses, the lesions enlarge and develop into thick, scabby growths on the fruit surface making them unfit for sale. If growers lose as little as 10% of their production to apple scab, it could eliminate all of their profit for the season. At present, the use of fungicides is the primary means of controlling the disease.

Fungicide resistance development in the apple scab fungus is an extremely important problem facing commercial apple production in Ohio orchards. Many of the fungicides that are currently used in Ohio, including the sterol-inhibiting fungicides and strobilurin fungicides are beginning to lose or have lost their effectiveness for controlling apple scab due to the development of fungicide resistance in the apple scab fungus.

Michael Ellis

Loss of the sterol-inhibiting fungicides has forced Ohio apple growers to return to using a protectant fungicide program where fungicides are applied on a 7-day schedule in place of an extended-protectant program where they are applied on a 10–14 day schedule. The change back to using a protectant program is resulting in an increased number of fungicide applications resulting in greatly increased costs to growers.

Preliminary experiments conducted in 2006 indicated that dormant applications of phosphite fungicides combined with the bark penetrating adjuvant Pentra-Bark® provided good control of early season (primary) apple scab without the use of additional fungicide applications. This could result in the elimination of four to five fungicide applications. The major objective of these studies was to conduct additional field trials to determine and demonstrate the efficacy of dormant and conventional foliar applications of a phosphite fungicide for control of early season apple scab.

The dormant applications in 2007 and 2008 did not perform as they did in 2006; however, results from 2008 were much better than 2007. In 2007 and 2008 the dormant applications provided a significant level of scab control; however, the level of control was not commercially acceptable. Results suggest that dormant applications of the phosphite fungicides are not effective for providing a consistent and commercially acceptable level of scab control and will not be recommended for use. On the other hand, foliar applications of the phosphite fungicides provided good control of apple scab and will be recommended for use in the apple scab disease management program.

The addition of the phosphite fungicides to our current arsenal of fungicides for combating apple scab will provide growers with new fungicide chemistry that can be used in alternating spray programs to prevent the further development of fungicide resistance in the apple scab fungus.

Development of a Novel Nematode Release System for Preventive Management of the Fungus Gnat *Bradysia difformis* in Ornamentals

Cañas, Luis, Entomology

The greenhouse, nursery, and landscape industries are quickly growing, and apart from providing work to local residents, these industries provide plants that are used to improve how landscapes and homes look. Recent changes in industry practices have called for emphasis in developing production techniques that are sustainable. One example of this is to use pest management practices that rely more on natural controls such as the use of nematodes that kill fungus gnats. While these sustainable techniques are important, sometimes their use is limited because the labor costs required to release these organisms is high.

Insect-killing nematodes have been shown to be effective at reducing fungus gnat infestations. However, their application and release is labor intensive and expensive. This study evaluated different nematode delivery methods to prevent fungus gnat infestation on poinsettia cuttings rooted on Smither's Oasis wedges. Two species of nematodes, *Heterorhabditis bacteriophora* and *Steinernema feltiae,* were delivered either by watering pots recently transplanted with rooted poinsettia cuttings with a nematode water solution; dipping rooted poinsettia cuttings into a nematode water solution immediately before transplanting; or via adding insect cadavers infested with the nematodes to the pots receiving rooted poinsettia cuttings.

To measure the effectiveness of each nematode delivery method, fungus gnat immature recovery and adult emergence was recorded. In addition, soil samples were collected and exposed to wax worms to evaluate the establishment of the nematodes.

Adult fungus gnat emergence decreased significantly when plants were treated with either nematode. Nematodes delivered via insect cadaver and drench decreased fungus gnats significantly when compared to plants without nematodes. Most likely, the nematodes in the dipping solution did not have enough time to establish in the media. This study shows that either nematode was able to establish in the soil media, therefore, the release of nematodes to poinsettia plants rooted on media can be an effective biological control practice against

Claudia Kuniyoshi, Luis Cañas (right)

fungus gnats. This system, if implemented by commercial growers, could prevent potential fungus gnat infestation and reduce the cost of nematode releases.

The results from this project show that it is possible to release these nematodes using insect cadavers. Such practice most likely can be mechanized, which would result in significant labor savings and the widespread use of more sustainable pest management techniques.

Powdery Mildew Fungicide Insensitivity Evaluations on Pumpkin Foliage

Jasinski, James R., OSU Extension
Rhodes, Landon H., Plant Pathology
Miller, Sally A., Plant Pathology
Precheur, Robert J., Horticulture and Crop Science

Powdery mildew (PM) is a key pathogen on cucurbit crops (watermelon, muskmelon, squash, cucumbers, pumpkins) not only in Ohio, but also throughout the country. The spores of this pathogen do not overwinter in Ohio, but blow in on frontal weather systems from the southern region of the United States. Over the past several years, this pathogen has exhibited quantitative resistance where control can be achieved at only high fungicide rates and qualitative resistance, where even increases in the fungicide rate will not result in better control. These two types of resistance are usually related to specific fungicide classes.

In recent years, anecdotal evidence from Ohio growers, particularly in the northeast, suggested specific compounds seemed to have lost their efficacy against powdery mildew. The basis of this project was to use field and greenhouse studies to determine which commonly used fungicides effectively control PM on susceptible or powdery mildew tolerant pumpkin leaves. Investigators hope this project will also convey which fungicides, if any, have lost their effectiveness to control powdery mildew.

Two types of experiments were conducted at multiple sites in northeast and southwest Ohio. Ten different fungicides were evaluated in both trials, with each fungicide being applied to pumpkin leaves below label rates in the first trial to identify potential PM resistance, and applied at high labeled rates on pumpkin leaves to identify field level resistance. The trial sites have a wide geographic spread, which allowed researchers to better characterize the scope of the resistance issue.

Based on data from the sites in the northeast and southwest regions of the state, these experiments indicate strobiluron fungicide (Cabrio, Flint, Quadris, etc.) insensitive strains of PM existed in Ohio in 2008. In future studies, researchers hope to better quantify the scope of the field resistance, and see if it changes over time. As a result of these findings, growers need to examine their PM control programs and avoid spraying strobiluron fungicides to manage PM on cucurbits. These fungicides can still be used to protect against other fungal pathogens on this crop group.

James Jasinski

Using Biological Control to Manage Aphids on Hydroponic Lettuce

Cañas, Luis, Entomology

In Ohio an industry that is growing every year is the production of hydroponically grown vegetables. Currently, there is a big push to produce locally grown food and also to develop production systems that are sustainable. For this to happen, insect management when producing vegetables in hydroponic systems needs to rely on integrated pest management methods. One important step is to develop systems that rely on biological control to maintain pest populations at low levels in greenhouses, and that use chemical applications as the last step in the pest management program. This will result in sustainable programs that also have less impact on the environment.

The main objective of this study was to evaluate the use of various biological control agents for management of the green peach aphid (an insect capable of transferring viruses), *Myzus persicae*, on hydroponically grown lettuce. The biological control agents will be part of an overall IPM management program that will be used to keep aphids below damaging levels. Several biological control agents will be used in this project, including lacewings, *Chrysoperla carnea*, and the aphid parasitoid *Aphidius colemani*. Their activity will be compared using direct releases. These biological control agents have been successfully used in other areas for aphid management; however, their use is just starting here in Ohio.

Scientists collaborated with local growers for this study. Investigators found there were two species of aphids affecting the production system— the green peach aphid and the potato aphid. Initial infestations had a large number of green peach aphids. The best biological control agents were a combination of lady beetles and the wasp parasitoid *Aphidius colemani*. Using these biological control agents, researchers were able to reduce the populations of aphids to manageable levels. The releases had to be done every week to keep the aphids under control. In turn, the reduction in the number of aphids lead to the production of higher quality lettuce and the reduction of expenses required to clean the plants before shipment. Furthermore, during the experiment scientists found that aphids preferred attacking Romaine lettuce followed by green lettuce varieties.

Researchers also were able to identify particular times during the year when aphid populations tend to increase very quickly. During the second year of work, the green peach aphid was replaced by the potato aphid. Research found this aphid was introduced to the greenhouse by ants. Therefore, the grower decided to add concrete floors to the greenhouse to reduce the reinfestation caused by ants. For management of the potato aphid, the best combination of biological control agents was that of lady beetles and another wasp. Since the project was started, the grower has only needed approximately 4 applications per year as compared to more than 15 in previous years. The project showed that it is possible to optimize the pest management methods for hydroponic lettuce production and that it is possible to rely both on biological control agents and on chemicals to successfully control aphids.

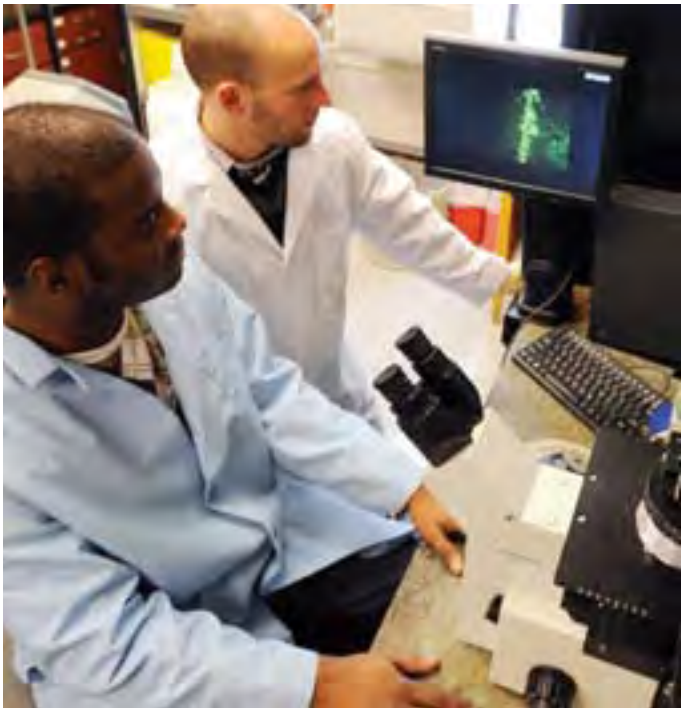
The production of locally grown vegetables is growing in Ohio and throughout the United States. In order for this system to be sustainable, best practices need to be implemented when dealing with pests and diseases. This project has shown that it is possible to rely on the use of biological control agents to reduce the populations of aphids that could damage hydroponically produced lettuce. It also has shown that it is possible to use different tactics, including chemicals, to maintain aphid populations at appropriate levels. This project can serve as an example of how to implement a proper IPM program in this particular system.

Karla Medina-Ortega, Luis Cañas (right)

Protective Effects of Antioxidants Against Cataractogenesis in Dogs

Failla, Mark L., Human Nutrition
Bomser, Joshua A., Human Nutrition
Colitz, Carmen, Veterinary Clinical Science

A cataract is a clouding of the natural eye lens, the part responsible for focusing light and producing clear, sharp images. Cataracts are a major problem for many middle aged, pure breed species of dogs. The Iams Company is a major global producer of high-end foods for companion animals. During the 1990s, investigators at Iams demonstrated that lutein enhanced the competency of the immune system in dogs. Lutein is a plant pigment in the carotenoid family that participates in the light harvesting activity required for the process of photosynthesis and filters blue light that can damage proteins, DNA, and membranes in plants. It has been shown that lutein is selectively accumulated in both the human lens and the macula region of the retina. Epidemiological studies suggest that the risk of developing cataracts in the human lens and age-related macular degeneration (AMD) is inversely proportional to dietary intake, as well as plasma levels, of lutein. Moreover, the amounts of lutein in these ocular tissues are significantly decreased with cataracts and AMD. These associations and the well-established antioxidant properties of the carotenoids have led to the proposal that lutein protects eyes against the damaging effects of ultraviolet (UV) radiation and oxidative stress.



Brian Stephens, Joshua Bomser (right)

Lutein is now included in Iams companion animal food formulations. The claim that Iams products strengthen immunity in dogs has played a central role in the marketing efforts of the company. In order to test and evaluate the impact of lutein on ocular health, scientists from The Ohio State University began a trial to validate these claims.

Dogs recruited to this study at The Ohio State University Veterinary Medicine Hospital were given biscuits with or without lutein. Blood samples were taken pre- and postfeeding and lutein levels were measured after 30 days. In addition, aqueous humor, a substance found between the lens and the cornea, was taken from canine eyes during cataract surgery and evaluated for antioxidant status and lutein levels. Although lutein levels were increased in the plasma of dogs provided the biscuits containing lutein, no changes in ocular levels of this carotenoid were detected. In addition, no changes in the antioxidant capacity of aqueous humor were observed in dogs supplemented with lutein compared to control animals. The most likely explanation for our lack of positive data demonstrating a beneficial effect of lutein on ocular health may be related to the relatively short duration of lutein supplementation provided in this study. Future work may involve a longer supplementation period, as well as the recruitment of additional dogs to this study.

Profiling Rumen Microbial Communities to Increase Efficiency of Microbial Protein Synthesis and Prevent Milk Fat Depression

Firkins, Jeffrey L., Animal Sciences

Methane is not only a potent greenhouse gas but also contains a high amount of potential energy. With about 1.25 million cattle, the state of Ohio has an important stake in devising strategies aimed at reducing methane production. These strategies have to be executed with no negative impact on the cost-benefit ratio of animal production while achieving positive environmental results in a timely and cost-effective way. The use of inhibitors such as monensin, an antibiotic, offers such a practical strategy, but dietary conditions (such as feeding monensin with unsaturated fat or feeding high amounts of grain) that reduce methane production are also associated with milk fat depression. Milk fat depression can reduce profitability on farms because of the strong demand for butterfat. Scientists hypothesized that the studies of rumen protozoal ecology would help design strategies to effectively reduce methane production while preventing milk fat depression.

The investigators' approach with the artificial rumens allowed researchers to evaluate protozoa without the confounding factors that are inherent with protozoal removal in the cow, yet it is unique compared with other laboratory approaches by being much better able to simulate the actual conditions of the cow. Finally, it allows for the quantification of methane production much more accurately.

The first objective was to run a series of microbial inhibitors that were combined with molecular biology techniques to study how methanogens influence the ecology of protozoa and bacteria. Researchers wanted to determine if they could decrease protozoa and their associated methanogens without decreasing the ability of the desirable bacteria to work in the rumen.

For the second objective, cows were fed diets that contained either alfalfa hay or corn silage as the sole forage source in different combination with or without the addition of monensin and molasses. Scientists wanted to determine if the decrease in milk fat seen sometimes on dairy farms depends on the type of forage fed to the cows or the amount of sugars available in the diet. Diet digestibility, ruminal fermentation, and milk quantity and composition were determined.

Jeffrey Firkins

For the third objective of the study, researchers wanted to test if feeding monensin to control the extent of amino acid deamination combined with fat to decrease protozoal abundance might improve the efficiency of microbial protein synthesis and decrease the wasteful intra-ruminal recycling of feed protein in dairy cows. Diets supplemented with coconut oil were compared to animal vegetable fat to evaluate their effectiveness as anti-protozoal agents.

When testing for the first objective, the elimination of protozoa did not decrease methane production. In fact, the selective elimination of a certain group of methanogens actually decreased protozoal growth rate and might reduce the efficiency of conversion of feed protein into milk protein. The elimination of protozoa significantly increased the outflow of specific fatty acid isomers that are strongly correlated with decreased milk fat production.

In future experiments, scientists are planning to alter conditions so that protozoa have decreasing generation times to assess how this affects protozoal growth and intra-ruminal recycling of protein. Several OARDC researchers are currently collaborating with scientists at Pennsylvania State, Virginia Tech, and University of California-Davis to further assess the biological and quantitative ramifications of rumen protozoa on the efficiency of conversion of dietary protein into microbial protein, which supplies the dairy cow with her most abundant source of protein and likely has the largest influence on our ability to consistently reduce urinary nitrogen excretion into the environment.

Evaluating Organic (Bio Plex®) Trace Minerals in the Diet of Reproducing Female Pigs on Ovulation Rate, Embryonic Survival, Uterine Crowding, and Mineral Composition of Conceptus Products

Pope, William F., Animal Sciences
Mahan, Donald C., Animal Sciences

Modern swine herds are bred to have larger litters for purposes to increase returns and to decrease costs on a per sow basis. An increase in litter size could save Americans an estimated 50 million dollars per year on feed costs alone. According to the USDA, ARS report, increasing litter size by just one pig per litter equates to about $200 million a year to U.S. swine producers, both in feed reduction and increased sales. It was recently demonstrated that feeding organic trace minerals increased litter size by approximately one pig per litter over six parities.

There has been considerable investigative interest in optimizing energy and nutrient uptake to reproducing female pigs but dietary minerals, especially trace minerals, have been less scrutinized. Minerals are categorized in several ways; those required by the animal for biological functions are classified as essential minerals. These essential minerals are further subdivided into ones that are required in large amounts (major or macro minerals) or those that are required in smaller quantities (trace or micro minerals). Trace minerals include cobalt, copper, iron, iodine, manganese, molybdenum, selenium, and zinc. The present experiment will examine how some of these trace minerals affect litter size in gilts.

Two hundred ten gilts were utilized to examine if the previously observed increase in litter size resulting after replacing inorganic trace elements with an inorganic was due to improved ovulation rate, embryonic survival, and/or fetal survival. At 45 kg body weight, gilts were randomly assigned to one of four dietary treatments: (1) industry level of inorganic; (2) NRC level of organic; (3) industry level of organic; and (4) 1.5 times industry level of organic trace elements. They remained on those diets for five to six months until slaughter at day 30 of gestation. Resulting percent conception rate, ovulation rate, total embryos, total live embryos, and percent embryonic survival were unaffected by diet. Macro and micro

William Pope

content of embryonic and endometrial tissues collected at slaughter, and of allantoic and amnionic fluids, were analyzed in a subset of gilts from each treatment group. Amounts of macro and micro minerals were altered in numerous comparisons of endometrial or embryonic tissues, and in allantoic or amniotic fluids, of gilts fed organic versus inorganic trace elements.

Results of this experiment suggest that the advantage in litter size after feeding organic trace elements to developing gilts was due to events associated with improved fetal survival. Perhaps the interaction of macro and micro elements established as early as day 30 are subsequently manifest, as yet in an unknown mechanism, to improve fetal survival later in gestation. The premise of organic forms of dietary trace minerals increasing litter size is of economic importance to the swine industry in Ohio and warrants further investigation.

Inhibition of Muscle Atrophy by Dietary Conjugated Linoleic Acid

Belury, Martha A., Human Nutrition
Guttridge, Denis, Molecular Virology, Immunology and Medical Genetics

Muscle atrophy, or decrease in muscle size, is a serious and detrimental effect of cancer cachexia, which is a "body-wasting" syndrome. According to the American Cancer Society, this syndrome marked by loss of appetite, weight loss, weakness, and muscle wasting is one of the most devastating syndromes resulting from cancer and conditions such as AIDS. Cachexia affects about half of all cancer patients, especially those with advanced cancer of the lung, pancreas, or digestive system. It causes about 10% to 20% of all cancer deaths. Atrophy of muscle, linked to cachexia, occurs due to insufficient substrate for energy. Scientists have previously shown that dietary conjugated linoleic acid (CLA) reduced adipose, or fat, mass, and increased muscle steatosis, which could provide lipid as a substrate for muscle.

Researchers sought to determine whether mice with tumors that were fed CLA would sustain muscle mass, function, and metabolism longer than the other mice with tumors subsisting on a control diet without CLA.

The study found no significant differences between mice implanted with tumors that were fed a diet enriched with CLA compared to mice fed a control diet. Body weights and muscle masses of the mice were similar between mice with tumors who were fed CLA, and those who were fed control diets. Adipose deposit weights were also smaller in mice fed CLA and bearing tumors. Function of muscle as measured using strength grip testing of mice showed no difference between mice fed CLA and those who were fed control diets. These data suggest CLA will not be an effective therapeutic agent to delay the effects of cachexia on muscle atrophy.

In the future, investigators will research whether the effects of CLA on muscle in non-tumor bearing mice could be helpful for mice with tumors if the doses were timed specifically for when the mice experience overt muscle loss. Using CLA to drive lipid away from adipose and into muscle may be best achieved when also combined with an insulin sensitizing agent such as a thiazolidinedione drug.

Martha Belury

Martha Belury (left) and Michelle Asp

Potential Uses of Fiberfill™ Clusters Made of Polyethylene Terephthalate (PET):

Growing Media Component, Rooting Substrate, and Other Alternative Uses

Pasian, Claudio C., Horticulture and Crop Science
Batte, Marvin, Agricultural, Environmental, and Development Economics

Today, most ornamental plant material is grown in soilless substrates such as peat and bark. The extraction of peat from the earth is arguably unsustainable and its cost has increased. The availability of bark for use in the green industry is decreasing, causing increased cost to growers. Additional alternative soilless substrates would allow green industry growers greater choice and flexibility in growing quality crops while keeping production costs low.

Two different materials were evaluated as soilless substrate components for greenhouse crops. *Polyethylene terephthalate* (PET) is a common plastic used in synthetic fibers and food containers. A PET fiber was developed for use as a soilless substrate component. Cellulose polymer is derived from cellulose extracted from plants. Cellulose polymer was manufactured into either fiber or granules for use as a substrate component.

In one study, substrates were mixed using either PET fiber or cellulose polymer fiber at various ratios with coconut coir, another common alternative soilless substrate, in order to grow *Begonia semperflorens-cultorum*. Plants grown in 100% PET fiber were about 15% smaller than plants grown in 100% coconut coir. When begonias were grown in substrates in which cellulose polymer was a component, growth decreased as cellulose polymer percentage in the substrate increased. Plants grown in 100% cellulose polymer were 52% smaller than plants grown in 100% coconut coir.

Cellulose polymer fiber was also compared to peat moss. The control substrate consisted of 75% peat moss and 25% perlite. Four other substrates were mixed with increasing percentages of cellulose polymer replacing peat moss. Five bedding plant species were grown in the substrates: pentas, zinnia, basil, and vinca. In all five species, shoot dry weight significantly decreased with increasing percentage of cellulose polymer fiber in the substrate. It was speculated that this reduction was due to high water retention by the cellulose polymer.

PET fiber was evaluated for use as a substrate in the production of orchids. Orchids require a substrate with a high air space volume; therefore, they are usually grown in a bark substrate with large particles. Four other substrates were mixed using increasing percentages of PET fiber. As PET fiber percentage in the substrate increased, orchid leaf number and average leaf length increased. PET fiber provided an excellent substrate for the orchids.

PET fiber was also evaluated as a rooting substrate. PET fiber was manufactured into prefabricated rooting cubes. *Chrysanthemum morifolium* Chesapeake (garden mum) cuttings were stuck into either PET fiber rooting cubes or Oasis rooting cubes. Mums rooted equally as well in all rooting substrates, though root development was slightly slower in PET

Claudio Pasian

fiber. A sample of rooted cuttings from each substrate were potted into six-inch pots and grown to full saleable size. After four weeks, all plants were equal in size and quality.

PET fiber looks promising as an alternative substrate in orchid production. Orchids grown in 100% PET fiber grew more than those grown in 100% bark. Further work is needed to evaluate if this product consistently performs better than bark, and if so, why it performs better. Further work is also needed to test this product on more orchid varieties. Research is currently planned to test it within an orchid production facility in Ohio.

Characterization of Feedstocks and Candidate Mulches for the Development of a New Mulch Product for The Scotts Company

Basta, Nicholas, School of Environment and Natural Resources
Dayton, Elizabeth, School of Environment and Natural Resources

Innovation is essential in maintaining a competitive position in industry for leading companies in Ohio. It is essential to retaining current jobs and expanding to create new jobs. In the horticulture/landscape industry, new sources of garden mulches are needed to keep costs affordable for consumers. Mulches with a longer useful life than current products will appeal to customer desires for greater convenience and less labor because fewer applications are needed.

Currently most mulch products are based on tree bark or recycled wood products. However, these materials are becoming scarce as efficiencies in the lumber industries improve and demand increases. Also, the increased demand of organic feedstocks for alternative energy production is competing with mulch production for the same materials. Therefore, the materials to make mulches are becoming limited. For long-term economic and environmental sustainability, a system to utilize new, renewable sources of mulch feedstock needs to be established.

The goal of this research was to provide preliminary data to support a future effort by The Scotts Company to develop new, renewable, and sustainable sources of landscape mulches from low-value by-products or waste materials. This would be a value-added product that is environmentally and economically superior to current wood mulches. A system to identify and characterize candidate feedstocks (CF) suitable for mulch production for residential use is needed. This system needs to address two major issues—regulatory acceptance and malodor issues that may preclude the use of some alternative materials as a feedstock.

Two issues were investigated. The chemical and physical constituents of the mulch CF were evaluated to assure that it is suitable for residential use. Particular attention was paid to chemicals of concentration regulated by federal and state agencies. Scientists analyzed the total and environmentally important chemical content and properties important to plant growth. A method to evaluate malodorous substances either in the mulch or generated by microorganisms was developed. This method was used to measure malodorous compounds in CF. Researchers also used this method to track the disappearance of the malodorous chemicals over time to determine if the bad smell of the CF would go away.

The chemical composition of the CF met federal and state regulatory standards for soil application in residential settings. The CF contains many plant nutrients and will help fertilize plants. Other plant growth properties of the mulch show its soil application would be beneficial because it would help build soil nutrients and carbon content.

The results of this research have been identified as critical by The Scotts Company as part of a major initiative by Scotts to develop a new value-added product utilizing industrial by-products as feedstocks to develop a sustainable landscape mulch product. Initial product testing using customer focus groups has identified malodor as the number one objection to the mulch prototype. Results from this work have identified reduced sulfur compounds as the primary culprits causing malodor. Preliminary data from this project was essential to OARDC researchers in developing the second phase geared toward solving malodor issues quantified here.

Nicholas Basta

Creation of a Grass-Based Beef Research, Processing, and Marketing Initiative for the High-Value, Health Conscious Consumer Market Segment

Fluharty, Francis L., Animal Sciences
Kuber, Paul, Animal Sciences
Zerby, Henry N., Animal Sciences

The demand for locally grown food is increasing, and more consumers are demanding that their food products be grown using specific management techniques. In fact, the 2009 National Retail Grocers Association Consumer Panel Survey reported that 40% of consumers wanted more locally grown foods available, and 73% of consumers said that high-quality meat in the store was very important, with an additional 20% stating that it was somewhat important when choosing where to shop. Grass-fed beef is being touted by some consumer and marketing groups due to possible health benefits of beef from animals fed grass, and the higher fat content of grain-fed beef, which is generally higher in marbling.

When considering the production of grass-fed beef for the high-end consumer market, several factors become important: the cost of production; cooking and meal desires of the consumer segment being targeted; meat characteristics needed to meet those desires; fat characteristics of the beef product; the availability of processing facilities that are willing to create specific cuts of meat destined for the high-end consumer market; and the availability of marketing outlets catering to consumers who desire grass-fed meat products. In the meat industry, consumer acceptance and desires are driving forces, and palatability is the meat industry's term that refers to a consumer's overall perception of taste, tenderness, juiciness, flavor, and mouth feel. Ultimately, the success of any beef program is determined by meeting consumer expectations of these criteria and successfully marketing the beef products.

This project investigated the steps necessary for linking the consumer demand for grass-fed beef to Ohio farmers engaged in beef production, and Ohio's meat processors and potential markets. Activities included an investigation of French style meat processing methodologies; the production of a grass-fed beef production manual, which is available through the Small Farm Institute of Fresno, Ohio; and the creation of a working relationship between the U.S. Jersey Association, which has been working to create beef value from their beef steers, the Small Farm Institute, OSU Extension and OARDC Researchers, and the Ohio Forage and Grasslands Council, which culminated in a field day in June 2009 for 350 Jersey farmers that served Jersey grass-fed beef.

Future plans are to create a working relationship between the Small Farm Institute, the North Union Farmers Market of Cleveland, Ohio (as well as other markets), and OSU Extension personnel and OARDC researchers. Additionally, several grants are being pursued. Specific future plans include the investigation of nutritional strategies that enhance the production of grass-fed beef to meet the demands of direct markets; the evaluation of French meat processing and cutting techniques and then training Ohio meat processors in those techniques; the creation of an added-value opportunity for the bull calves born on Ohio grazing farms; and meeting the consumer demand from farmer markets customers for leaner cuts of meat by increasing the production of locally produced grass-fed beef. These grants are being coordinated in conjunction with the Small Farm Institute, which helps small farms develop profitable enterprises with sustainable environmental practices that support strong family and rural communities.

Francis Fluharty

Rapid Determination of Concord Grape Content in Commercial Grape Juices

Giusti, Monica, Food Science and Technology

According to the Ohio Grape Industries Committee, grapes are the number one cultivated fruit crop in the world. There are 20 million acres of grapes planted worldwide. Grapes are the most valuable fruit crop in the United States and in Ohio. The average grape production per acre in Ohio since 2004 has been between 1.5 and 4.0 tons, making Ohio grapes a major crop for commercial wines and juices.

The long-term goal of this work is to provide the juice industry and regulatory agencies with an effective tool to monitor juice composition. This work was based on the theory that unique chemical characteristics of Concord grapes can be detected by infrared spectroscopy and allow for discrimination and quantization of the percent Concord grape present in a 100% grape juice blend with the aid of multivariate statistical analysis.

The specific objectives were to develop multivariate classification models for the rapid discrimination of grape juices based on compositional differences associated with varietal diversity; and to develop multivariate regression models for the determination of Concord grape juice content in a 100% grape juice blend.

Welch's provided 17 authentic grape juice samples in concentrate including 100% White, Niagara, Red, and Concord grape juices. These samples were standardized to single strength juices, with standardized acidity (pH). Three portions of each of the juices were extracted separately and each extraction was analyzed via IR in triplicate in order to determine the variability these steps incorporate into the method. IR spectroscopy was then performed on the phenolic fractions analyzed by both classification (SIMCA) and regression (PLSR) statistical models.

The research data proved that it is possible to differentiate grape juices made from different types of grapes based on their IR spectral data. Based on the pattern recognition analysis of the samples, a very high level of discrimination power based on type of grape was achieved. All different types of grapes (Concord, White, Red, and Niagara) formed clearly separated clusters. An important observation was that different samples produced from Concord grapes were grouped together,

Monica Giusti

including Concord and Concord Bottoms grape juice samples from multiple tanks and growing locations. This demonstrates the model's suitability for this type of discrimination as well as the high level of reproducibility in our method. The model's discrimination power was also exhibited in the large distances between the clusters associated with differing grape varieties.

An abstract outlining this work has been submitted to the Institute of Food Technologists Annual Meeting and Food Exposition for presentation in a technical session. Scientists have also obtained funding from MAFMA to continue this work. The next step will be to work with more complex grape matrices to create a more robust PLSR model for prediction of Concord grape juice content in grape juice blends. Currently, a publication is being generated from this research.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Seed Grant Competition

The Seed Grant Competition is designed to encourage new and innovative research and to generate the preliminary data needed for successful application to competitive extramural funding sources. Seed Grants are supported at a maximum level of $50,000.

Phosphoproteomic Analysis of Pollinated Petunia Styles

Jones, Michelle L., Horticulture and Crop Science

Senescence is the last stage of plant development leading to the death of cells, organs (leaves and flowers), and whole plants. Senescence results in blossom fading, wilting, and shedding of the flower petals. The value of flowering plants is determined by the display quality of their flowers, and petal senescence has a detrimental impact on the shelf life and salability of ornamentals. Postproduction losses due to premature senescence during shipping and retail sale can be as high as 30%. Creating plants with delayed senescence will reduce postproduction losses and increase the profitability of floriculture producers and retailers. This research can have a significant economic impact on the state of Ohio where the wholesale value of floriculture crops is over $180 million. Increasing the postproduction quality of ornamentals also provides the consumer with a better plant that will establish more quickly and have a better display life in the home landscape.

Flower senescence allows the plant to break down the cells within the petals and remobilize nutrients to the developing parts of the plant before the petals are shed. The initiation and execution of senescence is therefore controlled by changes in the expression of genes and proteins within the flower. Studies of these changes in the petals have identified many proteins and genes involved in this cellular breakdown. The style is part of the female reproductive structure of the flower. The pollen grains land on the stigmatic surface of the style and grow through the style to the ovary to pollinate the ovules. These pollinated ovules develop into seeds. Once the style has been pollinated, a signal is sent to the petals to tell them that they have fulfilled their biological role of attracting a pollinator and to initiate the senescence program. Identifying the gene and protein changes that occur in the style immediately after pollination is therefore critical to developing an understanding of the internal plant signaling pathways that initiate petal senescence.

Ethylene is a plant hormone that controls the timing of flower senescence in many plants. Pollination induces ethylene production by the style and accelerates petal senescence in many flowers, including petunias. When transgenic petunias that are insensitive to ethylene are pollinated, petal senescence is not accelerated. Scientists can therefore use these ethylene insensitive petunias with delayed senescence to study protein changes in the style following pollination. The goal of this

Michelle Jones

research was to identify proteins that increased in abundance in pollinated petunia styles. The proteins that increased in both nontransgenic petunias (i.e., those that were sensitive to ethylene) and ethylene insensitive transgenic petunias were found to be proteins from the pollen that was applied to the stigmas. Proteins that increased in the nontransgenic petunias but not in the ethylene insensitive petunia styles were those hypothesized to be involved in the pollination-induced signaling pathways that lead to the senescence of the petals.

This experiment demonstrated that these techniques could be used to identify proteins in a species like petunia that does not have a fully sequenced genome. Additional sequence data is now available for this important floriculture model plant. This experiment also identified four proteins that are putatively involved in senescence signaling within the flower. Future experiments will focus on characterizing where and when these proteins and their associated genes are expressed in the flower. Transgenic plants will be created with reduced protein levels to prove that these proteins have a functional role in flower senescence.

Development of Highly Palatable Reduced Calorie Ice Cream and the Impact of Label Information on Consumer Acceptance

Delwich, Jeannine F., Food Science and Technology

According to the USDA, total ice cream production in the United States in 2005 was approximately 1.55 billion gallons with a value of billion dollars. Ohio produced approximately 2% of that total with a value of about 450 million dollars. The top Ohio producers are mostly local and appeal to customers seeking premium ice cream.

There will always be a demand for premium ice cream, but for Ohio industries to continue to grow or even to maintain market share it will be important that they respond to changing consumer demand. Consumers will accept some decrease in quality, but these initial products were not good enough to obtain repeat sales. To capture a portion of this market it is important that advantage be taken of new ingredients available to produce ice cream and that a balance be achieved between fat reduction and quality. It is also important to understand how much the name "reduced fat" or "low fat" impacts upon the consumers' perception of quality.

This research was conducted to determine if it would be possible to formulate a reduced fat ice cream product that would be as acceptable or nearly so as the full fat versions. In addition, a portion of the work looked at how the label affected consumer perception. Researchers hoped to answer the question, "Would a full fat ice cream be reduced in rating if it were labeled as reduced fat and vice versa?"

To produce low fat ice creams a number of natural gums and starches were used to replace the fat. These molecules bind water and essentially the fat is being replaced by a combination of carbohydrate and water. Chocolate ice cream—both full fat (10%) and low fat (4%)—was produced and presented to 100 panelists. They first rated two samples with random numbers. One was the full fat and one the reduced fat sample. They rated on a nine-point scale for how much they liked the ice cream, how smooth the ice cream was, dairy flavor, and chocolate flavor.

Panelists were then given four samples with random number identifiers. One was labeled low fat and was low fat, one labeled low fat that was really full fat, one labeled full fat that was full fat, and one labeled full fat that was really low fat. Panelists rated these four samples using the same nine-point scale for the same attributes (liking, smoothness, dairy flavor, and chocolate flavor). Results were analyzed for statistical significance.

The panelists significantly preferred the reduced fat product to the full fat control. The difference in liking was highly significant. When formulating reduced fat products the goal is usually to have no significant difference between the products. That is, the reduced fat is as good as the control. In this study the reduced fat chocolate ice cream was actually preferred by the 100-member panel.

There were some complicated significant differences in preference due to labeling. While these are interesting they did not affect the preference for low fat ice cream. Whether the samples were presented blind, with a correct label, or an incorrect label the panelist still preferred the reduced fat product with added starch.

The Department of Food Science and Technology will be making ice cream for campus food service for sale in a new facility near Mirror Lake. Some will also be sold in the Parker Dairy Store. If that is successful it will be served on a trial basis for dining services. Results will be a shared through the Food Industries Center with commercial producers in Ohio.

Assessment of Perinatal Docosahexaenoic Acid and Arachidonic Acid in a Premature Piglet Model

Lyvers Peffer, Pasha A., Animal Sciences

The national incidence of preterm infant birth has increased nearly 30% over the last two decades and accounts for 12% of total live births. In Ohio, the rate of infants born premature is greater than the national average and increased 14% between 1992 and 2002. While improved pediatric care has prompted increased survival rates, the short-term health care costs for premature neonates was a staggering $13.6 billion in 2001; however, the long-term costs of premature birth may be even greater as there is evidence that environmental influences during the critical period surrounding predisposes infants to disease later in life.

The transition from fetal to neonatal life relies on a continuous energy supply for rapid postnatal growth and development. While the developing fetus obtains this energy primarily from carbohydrates, the term infant relies on dietary fat. Considerable knowledge is available regarding dietary requirements to prevent essential nutrient deficiencies; however, there is uncertainty surrounding the optimal nutrient requirements of the preterm neonate. For the very premature infant (< 33 weeks of gestation) total parenteral nutrition is often required for the early postnatal period, but metabolic complications often present.

The availability of a suitable animal model is a primary limitation to advancing the understanding of the proper nutritional management of premature infants. With comparable maturity at birth, anatomical and physiological similarities, and similarities in essential nutrient requirements and natural milk fatty acid composition between the pig and human, neonatal pigs are an opportune animal model. Indeed, studies conducted in pigs have contributed to society's understanding of the nutrient requirements of human neonates to date.

With the incidence of premature birth steadily increasing, using the piglet model for determining appropriate nutritional management of the human neonate will have a significant impact on optimizing postnatal care and reducing current health care costs associated with preterm birth. As n-3 (docosahexaenoic, or DHA) and n-6 (arachidonic acid, or AA) family of fatty acids have received considerable attention in recent years as potential nutritional therapies for disease, a primary focus is to utilize the piglet model toward advancing knowledge in the area of n-3 and n-6 fatty acid metabolism in the premature infant.

(left to right) Liz Brockson, Jessica Martin, Pasha Peffer

Scientists evaluated the role of DHA and AA in intravenous solutions administered to preterm and term pigs over the first six days of life and examined how these fatty acids impacted energy utilization by the liver. Pigs received solutions formulated to contain DHA and AA at concentrations set to mimic the supply of these fatty acids to the fetus in-utero or concentrations set to mimic the supply from human milk. Understanding how the newborn utilizes energy sources from the diet toward growth and development is critical in prescribing appropriate nutritional therapies for the critically ill neonate while minimizing metabolic complications commonly observed in the preterm neonate receiving intravenous nutrition.

Data collected from preterm pigs administered intravenous nutrition supplemented with DHA and AA revealed that as dietary supply of these fatty acids increased, greater liver accretion of DHA and AA occurred. Greater utilization of glucose was also observed in term pigs receiving supplemental DHA and AA. The increased glucose utilization in term pigs receiving DHA and AA supplementation may protect against elevated blood glucose associated with intravenous feeding—a significant risk factor for neonatal morbidity and mortality.

A future goal for this research is to characterize the postnatal adaptive responses of skeletal muscle and liver responsible for glucose utilization when preterm and term pigs are administered intravenous solutions. The main objective will be to enhance current intravenous feeding protocols to minimize postnatal weight loss and improve long-term outcomes.

Association of Salamanders and Downed Wood in Riparian Forests of Headwater Streams in the Cuyahoga Valley National Park

Goebel, Charles, School of Environment and Natural Resources
Williams, Lance R., School of Environment and Natural Resources

Riparian areas are important features of any landscape, promoting many ecological services that are critical for healthy and productive ecosystems and watersheds. One important structural component of riparian areas that we know little about is the characteristics and ecological role of downed and dead wood (also called downed woody debris or DWD). DWD is a significant structural component of riparian areas that links aquatic and terrestrial ecosystems providing numerous ecosystem services. In terrestrial ecosystems (including the riparian area), DWD is an important component of decomposition and nutrient cycling, a fuel source for fire, and habitat for many animals.

One of the more important organisms to utilize DWD in headwater streams is salamanders. Salamanders use wood and other habitat as shelter and for access to increased food resources. Larval salamanders of many species in Ohio are also thought to use crevices and holes as shelter during their development in streams. Wood provides unique habitat characteristics that may be especially critical to salamanders. DWD retains and wicks water, providing moist terrestrial microhabitats. Finally, DWD provides a source of organic nutrients that can be utilized by aquatic invertebrates upon which salamanders prey. As resource managers work to better manage and restore Ohio's riparian areas, there is a critical need to fill gaps of knowledge related to the factors that influence riparian structure and function, including that of DWD.

The goal of this project was to understand how the structure of DWD changes across headwater forested riparian areas, and whether these anticipated differences influence salamander assemblages. For the purpose of this research, riparian areas were defined as the area beginning at the base of the stream valley wall and extending across fluvial terraces and floodplain, including the channel, and across to the opposite valley wall base. Along randomly chosen pieces of downed wood in each sample area, researchers searched for salamanders. Scientists collected measurements on species; length, weight, as well as environmental characteristics where the salamander was found including soil moisture, relative humidity, habitat where the salamander was located, and presence of other organisms including salamander prey.

Investigators found that most pieces of downed wood were relatively short as the mean total piece length of individual pieces of downed wood across the entire riparian area was 2.9 m, with the majority of pieces having a length of less than 2 m. Additionally, the majority of pieces had a volume less than .01 m3. The majority of pieces had minimum diameters between 6 cm and 8 cm. Similarly, the mean maximum diameter of DWD pieces was 13 cm and the majority of pieces had maximum diameters from 7 to 10 cm. The majority of pieces could be considered highly decayed.

The headwater riparian areas studied showed clear differences in the amount and characteristics of the DWD, which are related to the stream valley processes. For example, most downed wood pieces outside the stream bankfull channel were significantly longer, had significantly higher percent surface contact, and higher mean total volume than those pieces inside the stream bankfull channel. Additionally, despite observing salamanders at these sites during previous and the current research, few salamanders were found in these headwater streams once sampling began.

However, further investigation into these dynamics revealed large populations of non-native earthworms. There is recent evidence from the northeastern United States that there is a negative relationship between salamander abundance and non-native earthworm abundance. Investigators are currently discussing opportunities with the National Park Service to explore these relationships further.

The results of this study provide a much-needed baseline of information on the DWD characteristics of relatively undisturbed second-growth riparian forests for the region. As an extension of this work and the efforts to understand the ecology of riparian forests of the Cuyahoga Valley National Park, researchers worked with the National Park Service to develop a riparian prioritization model for the Park.

Charles Goebel

Novel Imaging Methodologies to Study Campylobacter Pathogenesis in Livestock Production Research

Rajashekara, Gireesh, Food Animal Health Research Program

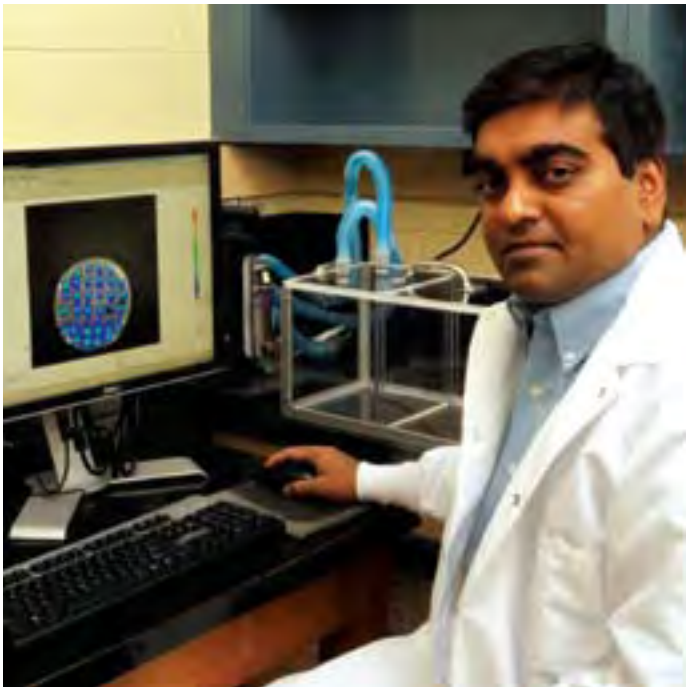
Campylobacter jejuni, a bacterium, is one of the most frequent causes of human gastroenteritis. A majority of human infections are attributed to the consumption of poultry and poultry products that are contaminated with *C. jejuni*. Since up to 70 percent of market age poultry are infected with *C. jejuni*, the control of human *campylobacteriosis* largely depends on reduction of *C. jejuni* incidence in poultry.

Currently there are no vaccines available against Campylobacter for use in poultry and current bio-security measures are not effective in controlling its occurrence in commercial poultry. Better understanding of *C. jejuni* pathogenesis in chickens and the genes that contribute to its persistence and spread is needed to design effective antimicrobial therapies and vaccines. This can be achieved through novel methodologies that would allow comprehensive understanding of the pathogenic process in vivo. Consequently, scientists proposed using bioluminescent *C. jejuni* to understand pathogen-host interaction in a greater detail and to identify genes that contribute to infection and persistence.

Researchers constructed bioluminescent *C. jejuni* for real-time in vivo pathogenesis studies. Scientists used the modified lux::transposon system to isolate bioluminescent *C. jejuni* that was not compromised in its growth properties, facilitating real-time pathogenesis studies. Investigators' overarching goal was to define the genetic requirements of *C. jejuni* for infection and persistence in vivo, identifying genes that contribute to infection and persistence of *C. jejuni* in chickens.

For the proposed study, investigators selected strains based on public health significance. A highly pathogenic *C. jejuni* strain was chosen and originally isolated from a patient during an outbreak of campylobacteriosis. This strain exhibits highly invasive in tissue culture cells and shown to be highly pathogenic in monkeys as well as human trials. Furthermore, scientists included in this study other Campylobacter species as a control.

The lux genes can be successfully expressed in *C. jejuni* and *C. coli.* Since no bioluminescent colonies were generated using different constructs above, scientists wanted to confirm whether bioluminescence could be induced in the *C. jejuni*



Gireesh Rajashekara

strain used in the study. Therefore, researchers constructed a bioluminescent plasmid by cloning a shuttle vector that can be efficiently mobilized from *E. coli* to *C. jejuni* and *C. coli*. The successful transformation of *C. jejuni* and *C. coli* suggested the potential of lux as a reporter for the study of Campylobacter colonization. The resulting vector containing the lux operon was then successfully introduced into *C. jejuni* and *C. coli*.

Before starting the chicken colonization studies, it was important to determine that the bioluminescent strains showed a growth pattern similar to the parental strains, indicating that the lux insertion did not affect the general growth property of the isolates. The results showed that the growth curve of the bioluminescent *C. jejuni* and *C. coli* strains was identical to the parental strains.

Further research is planned to repeat the experiment with two major modifications. First, scientists intend to treat the chicks with antibiotics for four consecutive days to eliminate precolonized Campylobacter. Three days following the termination of antibiotic treatment, allowing the antibiotics to be excreted from the chick's body, researchers will inoculate with bioluminescent strains and observe as above. If this fails, scientists will adopt a different approach and inoculate SPF embryonated eggs. Researchers are seeking to amend the animal protocol. If the options listed above failed to yield a satisfactory result, researchers will revisit the construction of the bioluminescent strains using a different parental strain that will be selected based on the ability to colonize the chicks more effectively.

Analysis of Swiss Cheese Bacterial Cultures to Streamline Control of Fermentation Processes

Rodriguez-Saona, Luis, Food Science and Technology

Swiss cheese is one of the most popular hard cheeses consumed in the United States. It is mainly characterized by the presence of eyes or holes and nutty flavor. In the year 2008, 32,795,660 kilograms of Swiss cheese were produced in the United States with Ohio being the leading producer. The starter cultures commonly used in Swiss cheese include *Streptococcus thermophilus, Lactobacillus helveticus,* and *Propionibacterium freudenreichii*. The final quality of cheeses is determined to a great extent by the action of cheese cultures and their enzymes on components of cheese curd. In turn, the effect of the starter cultures on cheese quality depends on the strain of the cultures used. Application of known strain of starter cultures could allow for improved and uniform final cheese quality. Understanding the role of cheese microflora, microscopic organisms, and their interactions on the biochemical and structural changes of cheeses would assist the cheese-maker to establish a uniform cheese quality, and to control and eliminate defects that ultimately threaten profitability and product expansion.

Traditional methods for detection and identification of cheese microorganisms have been labor-intensive and time-consuming. Application of typing techniques such as pulsed field gel electrophoresis (PFGE) and DNA-fingerprinting can identify bacteria up to the strain level; however, these methods are tedious and require highly skilled staff, which has limited their routine use in industry because of their sophistication.

Advances in Fourier Transform Infrared (FT-IR) spectroscopic instrumentation combined with data analysis have made this technology ideal for large volume, rapid screening, and identification of microbial populations. Infrared spectroscopy provides valuable information of the biochemical composition of the samples, especially in the fingerprint region, used for the identification and sub-typing of bacterial species. The objective of this study was to build a classification model for the Swiss cheese cultures at the strain level using FT-IR microspectroscopy. The proposed technology is simple, fast, highly specific, and requires minimal sample preparation. Infrared microspectroscopy (IRMS) is a relatively new tool for analysis of biological samples that improves significantly the sensitivity, reproducibility, differentiation, and speed capabilities of the infrared technology.

The procedure provided highly specific mid-infrared spectral patterns associated mainly with major cellular constituents of the microorganism. The developed models were able to classify all *Streptococcus thermophilus* (13), *Lactobacillus spp.* (20), and *Propionibacterium freudenreichii* (10) at the strain level. All strains were previously typed using PFGE. The model also provided information useful in identifying the similarities between strains.

For improved detection, the library of Swiss cheese culture strains could be expanded by including additional culture strains used in Swiss cheese production. In addition, this method could be applied to build classification models for other cheese and dairy starter cultures. The combination of hydrophobic grid membrane filters and Fourier Transform Infrared microspectroscopy allowed for rapid classification of several Swiss cheese starter and non-starter cultures at the strain level. This information would enable the cheese-maker to have a detailed overview of the microbiological status down to the strain level of the starter culture and product, which allows for correction measures to be taken early in the process, limiting production of inferior quality cheese and minimizing defects.

Luis Rodriguez-Saona

Profiling Chinese Consumers' Preferences for Soy-Based Dietary Supplements

Stoel, Leslie, Consumer and Textile Sciences
Chung, Jae Eun, Consumer and Textile Sciences

In Ohio, soybeans were the top commodity in terms of cash receipts in 2004 and accounted for the largest number of planted acres in Ohio in 2002, making Ohio the sixth largest soybean planter in the United States. However, with ethanol production driving acreage into corn, Ohio's leading soybean position may be in jeopardy. Expanding food uses of soybeans has been noted as a way to increase demand for soybeans. However, increases in U.S. food uses may not be large enough to prevent shift in acreage from soybeans to corn. Therefore, manufacturers and marketers of soy-based dietary products need to look at key export markets, such as China, to increase demand. The Chinese are known to be health conscious. Success in China, however, will require determination of consumer attitudes towards soy-based dietary products and beliefs about health and well-being and other factors that drive intentions to purchase these products.

The proposed research will be the first academic attempt to identify characteristics of soy-based dietary supplement users in China and to specify factors that influence purchase of these products by Chinese consumers. This study will allow scientists to suggest how Chinese soy-based dietary supplement consumers differ from U.S. consumers examined in previous research. The benefits of the research relate to increased purchase of soy-based dietary supplements in China, a key international market. Success there will ultimately increase demand for U.S. soybeans. Culturally, the Chinese market is very different from the U.S. market; therefore, knowledge of this information is critical for producers who wish to successfully distribute dietary supplements in China.

Leslie Stoel (left) and Jae Eun Chung

Researchers need to understand who dietary supplement users are in China to produce and market the right products there. In addition, understanding the factors that influence purchase and purchase intention enables marketers to provide the right information to consumers to help them make a good purchase decision. Such information may be useful in the development of advertising and promotional efforts, packaging, and even selection of appropriate sales/retail outlets. All of these play a key role in the success of products in a market, which will affect demand for soybeans.

Scientists expected to find that, when compared to non-users, Chinese dietary supplement users would be older, have higher incomes, and would be more educated. The results showed that users were less educated, but their income and age were no different than non-users. This is very different than dietary supplement users in the United States, suggesting that more research is needed to better understand Chinese consumers.

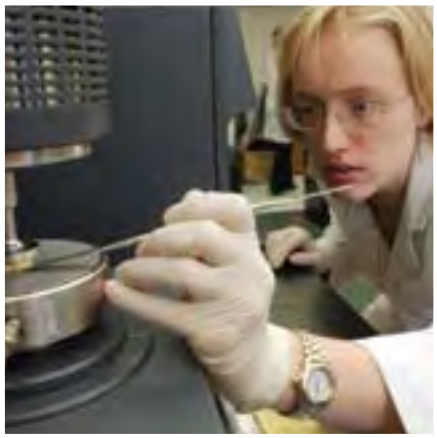
Researchers also found that Chinese consumers were more likely to purchase dietary supplements when (1) they know more about the products, (2) they feel the products do have health benefits, (3) they think their friends and family want them to take the products, and (4) they have control over their ability to take the products and they are able to find the change to buy the supplements.

To help companies successfully market soy-based food products in China, and increase demand for U.S. soybeans, research should be conducted on other types of soy foods, such as packaged soy milk, tofu, or baby formula. While soy milk and tofu are widely available in China, they are not prepackaged and are not branded. Opportunities exist to sell branded, packaged soy foods, once marketers have a better understanding of Chinese consumers. Based on the research findings, investigators have submitted a research proposal to the USDA-AFRI Markets and Trade program to study Chinese consumer preferences for and responses to soy milk, tofu, and baby formula made from U.S. soybeans. In addition, researchers will use the consumer response data to estimate potential impact on the demand for U.S. soybeans.

Student Projects

The Director's Undergraduate Research Competitive Grant Program, funded to a maximum of $3,300 per award, provides undergraduate students with a professional grant-writing, research and reporting experience. Projects are designed, submitted for review, and carried out with a faculty mentor. Once the project is completed, students take an independent studies class to write their research report in the form of a scientific journal article, using their faculty advisor as an editor. Some of these reports are published and many students present their research at professional meetings and competitions.

The Graduate Research Competitive Grants Program offers two categories of funding. Doctoral students may receive up to $5,000 per award and master's students up to $3,000 per award. Graduate students who received awards are asked to serve on a panel to review applications in the following year's competition. This experience provides students with an opportunity to develop their skills in grant-writing and reviewing—skills essential for them in their professional careers.



The Variation in the Chemical Composition of Crude Glycerin

Gott, Paige, Animal Sciences
Eastridge, Maurice L., Animal Sciences

The lack of knowledge about the component concentrations of crude glycerol is limiting its use as a feedstuff. The goal of this project was to determine the concentrations of various compounds and their variation within crude glycerin. Sixteen samples of crude glycerin from biodiesel producers primarily from the Midwest were collected. The samples were procured from nine different vendors between January 2007 and February 2009 with the majority, nine of 16, being collected during October 2008. The glycerin in these samples resulted from biodiesel produced from soybean oil, canola oil, tallow, and restaurant waste. Color and viscosity of the samples varied.

The ash was very variable due to the catalyst used in the production of biodiesel and the different steps used in purifying the glycerin. This also resulted in the concentration of sodium being quite high and variable. Ethyl alcohol concentration was low in all of the samples. The concentration of methanol was the most variable among the major components that researchers analyzed in the samples, reflective of the methanol added during the biodiesel production for formation of fatty acid esters without separation of the alcohol from the glycerin.

Moisture was the next most variable in the samples. Concentrations of fatty acids in the samples were negligible. Glycerol concentration in the samples was also quite variable. These data reveal that the composition of crude glycerin is quite variable, the high concentrations of methanol will limit the use of glycerin as animal feed from some sources, and the high concentrations of components other than glycerol will reduce the energy concentration of crude glycerin.

The Role of Arbuscular Mycorrhizae in Created and Natural Wetlands of Central Ohio

Hossler, Katie, School of Environment and Natural Resources
Bouchard, Virginie L., School of Environment and Natural Resources

Natural freshwater depressional wetlands are nutrient-rich, productive ecosystems, capable of supporting a variety of flora and fauna. These wetlands play a key role in the cycling of carbon, nitrogen, and phosphorus and often function as carbon and nutrient sinks in the landscape. Current U.S. wetland policy permits the destruction of these complex systems with mitigation by the construction of new wetlands. The created wetlands, however, are often of inferior quality, primarily due to construction in nutrient-poor soils. One key to improved success in wetland creation may be the association known as arbuscular mycorrhizae (AM).

Mycorrhizae are specialized associations between plant roots and soil fungi. One benefit to the plant provided by AM is better access to soil nutrients. Such associations are known to be critical to the survival of many prairie plants and consequently prairie restoration projects often inoculate with AM fungi to increase the likelihood of restoration success. A similar strategy may be advantageous in wetland restoration and creation projects, but little is known about the role of AM in wetland environments.

Investigators observed a definite fungal presence in the plant roots, but need to verify that the fungi they are observing are AM fungi. Researchers are in the process of examining the roots at higher magnification for arbuscules—the characteristic feature of AM fungi and indication that the plant root-fungi relationship is mutually beneficial. Scientists expect to find that AM are more prevalent in the higher quality natural wetlands, and in the more successful and/or older wetland creation projects. Results from this study will be useful in providing recommendations for improved wetland creation and restoration, and more fundamentally, in furthering the understanding of the freshwater marsh ecosystem.

Assessing the Role of Soil Properties, Soil Moisture Levels, and *Phytophthora cinnamomi* in a Decline Syndrome of *Quercus alba* in Southern Ohio

Nagle, Annemarie, Plant Pathology
Bonello, Pierluigi, Plant Pathology

Ohio's forests provide a wide array of services to the state and its residents, including timber and pulpwood production, recreational opportunities, wildlife habitat, and resource preservation. The majority of Ohio's forestland lies in the southern and eastern portions of the state, with approximately 10% contained in managed, state-owned property. The dominant tree species in many of these forests is white oak. White oak is also the most valuable species from a timber standpoint, contributing heavily to the $15.1 billion the timber industry brings to Ohio every year. In 2003, foresters and land managers of several state forests in southern Ohio began noticing very widespread and rapid death of mature, dominant white oaks. The need to create an effective management plan for the massive timber losses, as well as the ecological importance of white oak as a source of wildlife food and habitat, necessitated investigation into the cause of the mortality.

Initial research into the mortality of the white oaks in southern Ohio indicated the trees were suffering from a decline syndrome, a term used to describe a decrease in tree vigor and life span attributed to a complex interplay of long-term, predisposing environmental factors and shorter-term environmental and/or biotic stressors. Unlike tree mortality caused by a single insect, pathogen, or environmental cause, the factors causing decline syndromes can be very difficult to pinpoint.

In 2004, a survey of forested sites in nine states revealed the presence of the tree pathogen *Phytophthora cinnamomi* in the soils of forests where white oaks were dying. *P. cinnamomi* is a globally distributed, highly destructive, root-rotting pathogen whose reproduction and dissemination are closely tied to the presence of moisture in its environment. The majority of the white oak mortality in southern Ohio was associated with low-lying, watercourse areas, and occurred during years of excessive rainfall, which pointed to the possible involvement of *P. cinnamomi* in the decline syndrome. More research was needed before an association between pathogen presence and oak mortality could be made. This research sought to explore poorly understood elements of pathogen biology, and the relationship between the quantity of pathogen present in a forest stand and tree health.

The decline was patchy across the landscape, and some tree stands appeared healthy, while others contained many dead trees. During the summer of 2008, four different tree stands were intensely surveyed at Scioto Trail State Forest: one healthy with *P. cinnamomi* present; one healthy with *P. cinnamomi* absent; one declining with *P. cinnamomi* present; and one declining with *P. cinnamomi* absent.

By quantifying *P. cinnamomi* in different areas and at different time points, investigators hoped to determine the relationship between environmental factors, tree health, and pathogen activity. The most important finding of this research was that there is a very strong relationship between stand health and pathogen activity, with the declining stands having significantly more *P. cinnamomi* than healthy ones. Establishing this relationship provides more evidence that this pathogen might be contributing to tree death.

Repeating the field trials over the course of another summer would provide additional information about population dynamics of *P. cinnamomi* and its relationship to white oak decline. Evidence that *P. cinnamomi* aids in decline is widespread in affected forests and is dependent upon abundant moisture should influence timber management decisions in the future and has the potential to greatly affect the timber industry as a whole.

Enrico Bonello

The Sociological Dimensions of Environmental Markets: A Comparison of Two Water Quality Trading Programs in Ohio

Mariola, Matthew, Human and Community Resource Development
Moore, Richard H., Human and Community Resource Development

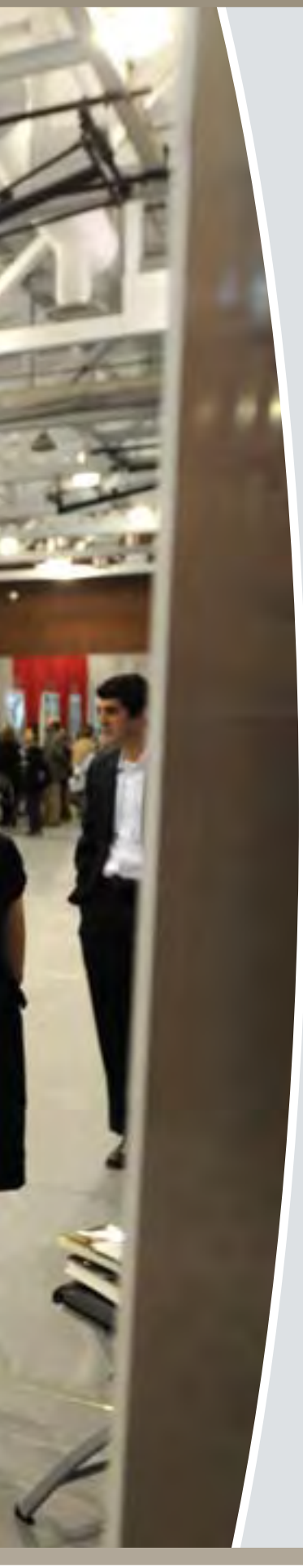
The sector known as water quality trading holds great promise for addressing the problem of nonpoint source water pollution more cost effectively than solutions of the past. Water quality trading is a scheme in which one water pollution discharger (typically a point source polluter such as a factory or wastewater treatment plant) pays another discharger (typically a nonpoint source polluter such as a farmer) to undertake certain water quality improvement strategies as a substitute for costly infrastructure upgrades. The actions of the latter entity have the same or better water quality effects as an upgrade by the former would have, at far less cost. The potential beneficiaries of this kind of initiative include farmers, who receive financial help in implementing conservation practices; municipal water customers, who can see savings on their utility bills; and the larger environment, including both plants and animals who depend on water quality for their survival.

Key to these benefits, of course, is that water quality programs work as anticipated, and it is here that scholarly research has a role to play. Stated very basically, the central issue that has occupied water quality trading analysts is what factors are critical to the success of trading programs. Most of the scholarly focus has been on economic or institutional issues narrowly defined, but in this study researchers broadened the focus to take into account an overlooked social factor. When trading programs include farmers as the nonpoint source participants, a particular hurdle is encountered: how to reach out and engage with a local farming population in order to get them to participate in the program.

Farmers have historically displayed ambivalence or outright skepticism toward many conservation programs, and just because water quality trading is a more "market-oriented" approach to conservation does not automatically guarantee their participation. All of the water quality trading programs in the United States and Canada that use farmers as the generators of water quality credits were surveyed to find out which factors played the strongest role in establishing a working relationship with them and getting them on board. The research was a combination of telephone interviews and site visits.

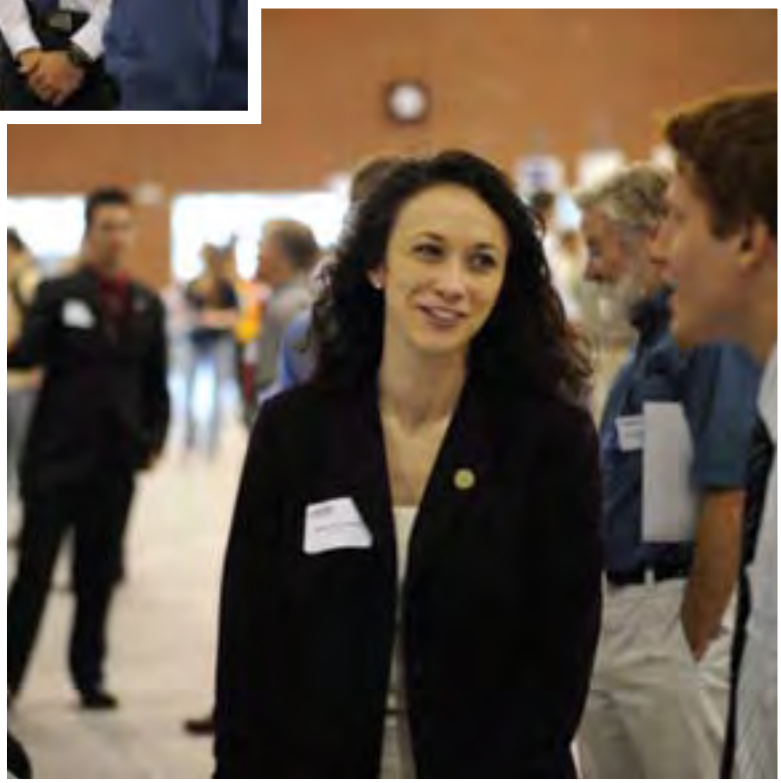
This research underscored the importance of trust relations when dealing with farmers, particularly in the realm of conservation. In order for programs to succeed at generating water quality credits and maintaining the conservation practices over time, it was found that two particular elements need to be in place. First, the individual or entity serving as the intermediary between a program's administrative staff and farmers needs to be a local group or agency with longstanding ties to the farming community. A nonprofit group or governmental agency with whom farmers do not have pre-existing trust relations will encounter significant hurdles in increasing farmer participation. Second, the local intermediary must possess the resources or institutional capacity to effectively serve its role, which could mean access to appropriate staff, finances, or time resources. The mere existence of a local agency is not sufficient; they must have the ability to devote time and effort to reaching out to farmers and working with individuals one-on-one.

Future research in this area is already underway. Most immediately, the concentration will be on converting the research into a number of manuscripts for submission to peer-reviewed journals. Also, scientists plan to link the results to the larger issue of conservation in general (in other words, not just water quality trading) and explore through more in-depth case studies of specific conservation programs the role of trust and social relations.



Publications, Presentations, and Graduate Students

Sharing knowledge through publications and professional meetings is an important part of research, as is training graduate students for careers in research. Using data from SEEDS projects, OARDC scientists have reported the publication of 678 peer-reviewed articles, bulletins, abstracts, and popular press articles. Over 1,200 presentations have been made in locations throughout the world. Eighty-five graduate students have been supported on SEEDS projects providing them with the skills needed to move forward with scientific research in the future.



Posters and Presentations

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Bai, S., D. Francis, B. Willard, M. Kinter, and M. L. Jones. Proteomic analysis of post-pollination and senescence signaling pathways in petunia flowers. American Society of Plant Biologists Annual Meeting, Boston, MA, July 2006.

Batallas-Huacon, Ronald E., and Luis A. Cañas. 2009. Development of a novel nematode release system for preventive and curative management of the fungus gnat *Bradysia difformis* in poinsettias. Poster display selected to be presented at The Ohio State International Scholar Research Exposition. Posters available for display outside President's Gee Office from Nov. 2 to Dec. 31, 2009.

Batallas-Huacon, Ronald E., Luis A. Cañas, Claudia H. Kuniyoshi, and Karla J. Medina-Ortega. 2008. Development of a novel nematode release system for preventive management of the fungus gnat *Bradysia difformis* in ornamentals. Poster display selected to be presented at The Ohio State International Scholar Research Exposition. Posters available for display outside President's Gee Office from Nov. 2 to Dec. 31, 2008.

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Eastridge, M. Large Animal Humane Officer Training Workshop. August 2008. Dutch Valley Restaurant, Sugar Creek, OH. Large Animals 101. Dairy Cattle—Identification, Body Condition, Feeding, and Shelter.

Eastridge, M. Agricultural Livestock Care and Conditions. June–July 2009. LuK Academy, Wooster, OH. Program for animal control officers. Large Animals 101. Dairy Cattle—Identification, Body Condition, Feeding, and Shelter.

Ellis, Michael, and William Strigfellow. Evaluation of dormant applications of phosphite fungicides combined with the bark-penetrating adjuvant Pentra-Bark for control of apple scab. Annual meeting of the American Phytopathological Society. Anaheim, California, August 2007.

Exner, C. Preliminary characterization of the mechanisms of persistence of *Pantoea stewartii* in its insect vector. OARDC Research Internship Program, Research Presentations, Wooster, OH, 2008.

Gott, P., M. Eastridge, and S. Karnati. The Variation in the Chemical Composition of Crude Glycerin. CFAES Undergraduate Research Forum, Columbus, OH, April 21, 2009.

Gott, P., M. Eastridge, and S. Karnati. The Variation in the Chemical Composition of Crude Glycerin. Denman Undergraduate Research Forum, Columbus, OH, May 13, 2009.

Hayes, Amanda. Greenhouse Sanitation: Efficacy of Disinfectants on Cutting Blades using Tobacco Mosaic Virus on Petunia as a Model. Brazil Research Exchange, University of Sao Paulo (Brazil) Undergraduate Research Forum, Sao Paulo, Brazil, November 2008.

Hayes, Amanda. Greenhouse Sanitation: Efficacy of Disinfectants on Cutting Blades using Tobacco Mosaic Virus on Petunia as a Model. Denman Undergraduate Research Forum, Columbus, OH, May 2008.

Holmes, K. L., P. C. Goebel, L. R. Williams, and M. Schrenengost. Environmental influences on the composition and structure of macroinvertebrate assemblages in headwater streams of northeast Ohio. 34th Natural Areas Conference, Cleveland, OH, 2007.

Holmes, K. L., P. C. Goebel, M. Schrenengost, and L. R. Williams. Riparian forest, aquatic habitat, and vertebrate influences on macroinvertebrate assemblages in headwater streams of Northeast Ohio. 6th North American Forest Ecology Workshop, Vancouver, BC, 2007.

Jones, M. L. Proteomic Analysis of Post-Pollination and Senescence Signaling Pathways in Petunia Flowers. 7th Annual World Petunia Days, Sutton Bonington, UK, September 16, 2005.

Jones, M. L. Proteomic Analysis of Pollination-induced Senescence in Petunia Flowers. Seventh International Ethylene Symposium, Piza, Italy, June 20, 2006.

Jones, M. L., L. Chapin, and S. Bai. Proteomic analysis of flower senescence. American Society for Horticultural Science Annual Meeting, Orlando, FL, July 21, 2009.

Kleinhenz, M. 2008. Grafting as a potential tool for field and high tunnel vegetable producers: Background, methods, and recent research results. North Union Farmers Market Growers Conference. November 3, 2008, Cleveland, OH. 91 attendees, 18 contact-hours. *Invited*.

Kleinhenz, M. 2008. Multi-state grafting project update. OSU-OARDC/OSUE Muck Crops Research-Extension-Industry Roundtable. October 23, 2008, Willard, OH. 21 attendees, 2 contact-hours.

Kleinhenz, M. 2008. Grafting as a potential complement to high tunnel production. OSU-OARDC Farm Science Review, Small Farm Center. September 17, 2008, London, OH. 47 attendees, 9 contact-hours. *Invited*.

Kleinhenz, M. 2008. Grafting as a potential tool for field and high tunnel vegetable producers: Background, methods, demonstration, and recent research results. The OSU-OFFER Program and Ohio Ecological Food and Farm Association Field Day. August 28, 2008, Wooster, OH. 40 attendees, 20 contact-hours.

Kleinhenz, M. 2008. Multi-state grafting project update. OSU-OARDC/OSUE Muck Crops Research-Extension-Industry Roundtable. August 28, 2008, Willard, OH. 19 attendees, 2 contact-hours.

Kleinhenz, M. 2008. Grafting as a potential tool for field and high tunnel vegetable producers: Background, methods, and recent research results. Mt. Hope Produce Auction Growers Meeting. July 30, 2008, Nashville, OH. 85 attendees, 21 contact-hours. *Invited*.

Kleinhenz, M. 2008. Grafting as a potential tool for field and high tunnel vegetable producers: Background, methods, and recent research results. Mt. Hope Produce Auction Growers Meeting. July 16, 2008, Salt Creek Township, OH. 164 attendees, 41 contact-hours. *Invited*.

Kleinhenz, M. 2008. Multi-state grafting project update. OSU-OARDC/OSUE Muck Crops Research-Extension-Industry Roundtable. June 26, 2008, Willard, OH. 20 attendees, 2 contact-hours.

Kleinhenz, M., Miller, S., and Francis, D. 2008. Grafting as a potential tool for field and high tunnel vegetable producers: Background, methods, and recent research results. Ohio Produce Growers and Marketers Association—OARDC/OSUE Summer Tour and Field Day. June 25, 2008, Wooster, OH. 90 attendees, 25 contact-hours. *Invited*.

Kleinhenz, M. 2008. Multi-state grafting project update. OSU-OARDC/OSUE Processing Crops Research-Extension-Industry Roundtable. June 24, 2008, Bowling Green, OH. 10 attendees, 1 contact-hour.

Kleinhenz, M. 2008. Grafting as a potential tool for field and high tunnel vegetable producers: Background, methods, and recent research results. The OSU-OFFER Program and Ohio Ecological Food and Farm Association Organic 101 Workshop. March 20, 2008, Wooster, OH. 20 attendees, 10 contact-hours. *Invited*.

Kleinhenz, M. 2008. Grafting as a potential tool complement to high tunnel vegetable production. The OSU-OARDC/OSUE and Cuyahoga Valley Conservancy High Tunnels 101 Workshop. March 14, 2008, Peninsula, OH. 32 attendees, 6 contact-hours.

Kleinhenz, M. 2008. Grafting as a potential tool for field and high tunnel vegetable producers: Background, methods, and recent research results. The OSU-OARDC/OSUE High Tunnels 101 Workshop. March 7, 2008, Plymouth, OH. 12 attendees, 2 contact-hours.

Kleinhenz, M. 2008. Grafting as a potential tool for field and high tunnel vegetable producers: Background, methods, and recent research results. The OSUE Knox County Winter Vegetable School. February 26, 2008, Fredericktown, OH. 25 attendees, 5 contact-hours. *Invited*.

Kleinhenz, M. 2008. Grafting as a potential complement to high tunnel vegetable production. Ontario Fruit and Vegetable Convention. St. Catherine's, Ontario, Canada. February 21, 2008. 60 attendees, 10 contact-hours. *Invited*.

Kleinhenz, M. 2008. Grafting as a potential complement to high tunnel vegetable production. The OSU-OARDC/OSUE and Ohio Ecological Food and Farm Association High Tunnels 101 Workshop. February 18, 2008, Granville, OH. 65 attendees, 13 contact-hours.

Kleinhenz, M. 2008. Grafting as a potential complement to high tunnel vegetable production. The OSU-OARDC/OSUE, Crown Point Ecology Center and Cuyahoga Valley Conservancy High Tunnels 101 Workshop. January 25, 2008, Bath, OH. 30 attendees, 6 contact-hours.

Kleinhenz, M. 2008. Grafting as a potential complement to high tunnel vegetable production. The OSU-OARDC/OSUE and Mt. Hope Produce Auction High Tunnels 101 Workshop. January 24, 2008, Mt. Hope, OH. 40 attendees, 8 contact-hours.

Kleinhenz, M. 2008. Grafting hypotheses and practices. College of Wooster Independent Study Seminar. January 17, 2008, Wooster, OH. 30 attendees, 2 contact-hours. *Invited*.

Kleinhenz, M. 2008. Vegetable grafting: Status and potential. Ohio Produce Growers and Marketers Association Fruit and Vegetable Growers Congress. January 14, 2008, Sandusky, OH. 40 attendees, 10 contact-hours.

Kleinhenz, M. 2008. Grafting as a potential complement to high tunnel vegetable production. The OSU-OARDC/OSUE High Tunnels 101 Workshop. January 8, 2008, Toledo, OH. 29 attendees, 6 contact-hours.

Kleinhenz, M. 2007. Grafting as a potential complement to high tunnel vegetable production. The OSU-OARDC/OSUE High Tunnels 101 Workshop. December 12, 2007, Zanesville, OH. 29 attendees, 6 contact-hours.

Mackey, D. Mechanisms of plant immune function against potentially pathogenic bacteria. PhD student workshop on The interactions between plants and microorganisms: From virulence to symbiosis, University of Gothenburg, Gothenburg, Sweden, September 2009.

Mackey, D. RIN4 is a multifunctional regulator of Arabidopsis immune defense against *Pseudomonas syringae*. 14th International Congress on Molecular Plant-Microbe Interactions, Quebec City, Canada, July 2009.

Mackey, David. Bacterial type III effectors inhibit plant defenses by perturbing vesicle traffic. Ohio State Plant Molecular Biology/Biotechnology (PMBB) annual symposium. Columbus, OH, April 2007.

Mackey, David. Confrontation between *Arabidopsis thaliana* and *Pseudomonas syringae*: Many battles decide the war! Invited seminar. Max Planck Institute, Cologne, Germany. December 2007.

Mackey, David. The role of the Hrp-dependent effector protein, WtsE, in the pathogenicity of *Pantoea stewartii* to *Zea mays*. NRI Awardee Workshop: Genes to Products Agricultural Plant, Microbe, and Biobased Product Research, Bethesda, MD, March 2007.

Martin, Jessica E., Jenny A. Campbell, Krizia Melendez, M. Elizabeth Brockson, and Pasha A. Lyvers Peffer. Evaluation of docosahexaenoic and arachidonic acid as modifiers of carnitine palmitoyltransferase in pre- and term pigs. Experimental Biology 2009, New Orleans, LA, April 2009.

Michel, F. C. Farm Scale Composting: Environmental Benefits, Challenges, and Economics. 2009 Midwest Manure Summit. University of Wisconsin Extension, Green Bay, WI, 2009.

Nemer, Kathleen, Kaz Koba, and Martha Belury. Anti-inflammatory Properties of Punicic Acid (c9t11c13-CLNA) in Skeletal Muscle of Mice. Denman Undergraduate Research Forum, Columbus, Ohio, May 14, 2008.

Nemer, Kathleen, Kaz Koba, and Martha Belury. Anti-inflammatory Properties of Punicic Acid (c9t11c13-CLNA) in Skeletal Muscle of Mice. Universidad de Sao Paulo Research Exchange Program, Sao Paulo, Brazil, November 3–7, 2008.

Pickworth, C. L., S. C. Loerch, and F. L. Fluharty. Limit-feeding can improve feed efficiency of beef cattle. The Ohio State University–Ohio Agricultural Research and Development Center Annual Conference, Columbus, OH, 2008.

Prabhakar, Veena, Nurdan Kocaoglu-Vurma, W. James Harper, and Luis E. Rodriguez-Saona. High-throughput differentiation of *Streptococcus thermophilus* and *Lactobacillus* spp. strains used in Swiss cheese production by infrared microspectroscopy. Ohio Agricultural Research and Development Center (OARDC) annual meeting, Columbus, OH, 2009.

Ren, J., J. Chung, L. Stoel, and Y. Xu. The Determinants for Chinese Consumers Intention to Use US-Made US-Brand Soy-Based Dietary Supplements: An Application of the Theory of Planned Behavior. Association for Consumer Research (ACR) 2009 National Meeting, Pittsburgh, PA. In Review, for fall meeting.

Rhodes, L. H., R. J. Precheur, R. M. Riedel, J. R. Jasinski, M. R. Kelly, and A. F. Trierweiler. Resistance to Microdochium blight in Cucurbita moschata and C. moschata x C. pepo hybrids. 2008 Ohio Produce Growers and Marketers Association (OPGMA) Congress, Sandusky, OH, January 14–16, 2008.

Rhodes, L. H., R. M. Riedel, R. J. Precheur, J. R. Jasinski, M. R. Kelly, A. F. Treweiler, G. M. Sutton, C. B. Gordon, and L. A. Wutz. Field Evaluation of Microdochium-resistant Pumpkins–2007. 2007 Pumpkin Field Day, Western Agricultural Research Station, South Charleston, OH, August 23, 2007.

Roe, Brian, and Tim Haab. Using Biomedical Technologies to Inform Economic Modeling: Challenges and Opportunities for Improving the Descriptive and Positive Analysis of Environmental Policies. Invited Presentation, Center of Energy Policy and Economics, Swiss Federal Institute of Technology, Zurich, Switzerland, November 16, 2007.

Roe, Brian, and Tim Haab. Using Biomedical Technologies to Inform Economic Modeling: Challenges and Opportunities for Improving the Descriptive and Positive Analysis of Environmental Policies. Special Conference on Frontiers in Environmental Economics, Washington, DC, February 26–27, 2007.

Roe, Brian, and Tim Haab. Understanding Human Response to Risk: An Overview of a Multidisciplinary Research Plan Involving Neuroscience, Genetics & Endocrinology. Invited Presentation, Department of Agricultural, Environmental, and Development Economics, Columbus, OH, November 30, 2006.

Roe, Brian, and Tim Haab. Understanding Human Response to Risk: An Overview of a Multidisciplinary Research Plan Involving Neuroscience, Genetics & Endocrinology. Invited Presentation, Department of Marketing, Fisher School of Business, Columbus, OH, November 9, 2006.

Roe, Brian, Tim Haab, David Beversdorf, and Howard Gu. Understanding Human Response to Economic Risk: An Overview of a Multidisciplinary Research Plan Involving Neuroscience, Genetics and Endocrinology. SCC-76 Meeting on Economics and Management of Risk in Agriculture and Natural Resources, Myrtle Beach, SC, March 16–18, 2006.

Roe, Brian, Tim Haab, David Beversdorf, and Howard Gu. Understanding Human Response to Risk: A Multidisciplinary Approach. Invited Lecture in Behavioral Studies, Swiss Federal Institute of Technology, Zurich, Switzerland, November 21, 2007.

Roe, B. E., M. R. Tilley, H. H. Gu, D. Q. Beversdorf, W. Sadee, T. C. Haab, and A. C. Papp. Financial and Psychological Risk Attitudes Associated with Two Single Nucleotide Polymorphisms in the Nicotine Receptor (CHRNA4) Gene. Society for Neuroeconomics Annual Meeting, Evanston, IL, September 24–26.

Roe, Brian E., Michael R. Tilley, Howard H. Gu, David Q. Beversdorf, Wolfgang Sadee, Timothy C. Haab, and Audrey C. Papp. Understanding Human Response to Risk: An Overview of a Multidisciplinary Research Plan Involving Neuroscience, Genetics & Endocrinology. Annual Meetings of the Agricultural and Applied Economics Association, Milwaukee, WI, July 26–29, 2009.

Sweeney, C. F., L. E. Rodriguez-Saona, and M. M. Giusti. Rapid Determination of Concord Grape Content in Commercial Grape Juices. IFT Annual Meeting and Food Expo, Anaheim, California, June 2009.

Wang, G. L. Development of High Throughput Approaches for Functional Genomics in Rice and Maize. Department of Biology Seminar, Bowling Green State University, OH, April 4, 2007.

Wang, G. L. Function of SPL11-mediated ubiquitination pathway in suppressing plant cell death and activating defense response in rice. Department of Botany Seminar, Oxford, Miami University, OH, Feb. 9, 2007.

Wang, G. L. The function of the SPL11-mediated ubiquitination pathway in suppressing cell death and activating defense response in rice. Department of Soil and Crop Science Seminar, University of Kentucky, KY, Sept. 26, 2006.

Wang, H. H. Antibiotic resistance by foodborne commensal bacteria. Multi-State Food Safety SDC-313 meeting, Orlando, FL, 2006.

Wang, H. H. Antibiotic resistance in foodborne microorganisms. U.S. Food and Drug Administration (FDA) public hearing, Rockville, MD, 2007.

Wang, H. H. Antibiotic resistant commensals in the food chain and potential impacts. Multi-State Food Safety SDC-313 meeting, San Antonio, TX, 2007.

Wang, H. H. Biofilms and antibiotic resistance gene transmission in the food environment. University of California Los Angeles (UCLA) School of Dentistry Seminar, Los Angeles, CA, 2007.

Wang, H. H. Foodborne microbes: Impacts on our lives. To Dairy Management Inc. Columbus, OH, 2006.

Publications

Abstracts, Conference Proceedings

Asp, M. L., M. Tian, A. A. Wendel, and M. A. Belury. Evidence for the early involvement of insulin resistance in the development of cachexia in mice bearing colon-26 tumors. FASEB J 2008;22:#1089.5.

Bonello, P. 2008. 2. Metabolomics and proteomics of systemic induced resistance in pine.

Chen, Songbiao, and Guo-Liang Wang. 2007. Development of a highly efficient protoplast-based gene expression system for functional genomics and proteomics assays in rice.

Chen, Songbiao, Lirong Zeng, Miguel Vega-Sanchez, and Guo-Liang Wang. 2006. Development of a highly efficient stem-derived protoplast system for transient gene expression and protein-protein interaction assays in rice.

Coplin, D. L., J. H. Ham, D. R. Majerczak, and D. M. Mackey. 2008. The WtsE virulence effector from *Pantoea stewartii*, a plant signal mimic?

Correa, V., D. R. Majerczak, E. Ammar, M. Merrighi, D. Coplin, R. C. Pratt, M. Redinbaugh, and S. A. Hogenhout. 2008. Characterization of *Pantoea stewartii* TTSS gene required for persistence in its flea beetle vector.

da Cunha, L., and D. Mackey. 2009. RIN4 is a multifunctional regulator of Arabidopsis immune defense against *Pseudomonas syringae*.

Doohan, D., and R. Wilson. 2009. Investigating the human dimension of weed management.

Gorocica-Buenfil, M. A., F. L. Fluharty, C. K. Reynolds, and S. C. Loerch. 2006. Effect of dietary vitamin A restriction on marbling in growing cattle.

Gorocica-Buenfil, M. A., F. L. Fluharty, P. Tirabasso, G. Lowe, and S. C. Loerch. 2007. Effect of vitamin A restriction on carcass characteristics and immune status of feedlot beef steers.

Gorocica-Buenfil, M. A., C. K. Reynolds, F. L. Fluharty, and S. C. Loerch. 2006. Diets containing low vitamin A and roasted soybeans affect adipose cellularity and muscle fatty acid profile of beef cattle.

Helser, L. A. 2007. Factors responsible for the occurrence of double ovulations and development of a system to induce double ovulations in beef cattle.

Jones, M. L., B. Shuangyi, B. Willard, A. Stead, and M. Kinter. 2007. Proteomic analysis of pollination-induced senescence in petunia flowers.

Karnati, S. K. R., C. V. D. M. Ribeiro, J. T. Sylvester, and J. L. Firkins. 2006. Inhibition of methane synthesis on biohydrogenation in the presence or absence of protozoa in continuous culture.

Karnati, S. K. R., J. T. Sylvester, L. E. Gilligan, and J. L. Firkins. 2006. Manipulation of fermentation profile and methane production with microbial inhibitors and protozoal retention in continuous culture.

Long, A. C., C. M. H. Colitz, and J. A. Bomser. 2006. Regulation of Gap Junction Communication by Protein Kinase C in Primary Canine Lens Epithelial Cells.

Oelker, E. R., C. Reveneau, and J. L. Firkins. 2006. Effects of molasses and monensin in alfalfa hay or corn silage diets on rumen fermentation, total digestibility and milk production in Holstein cows.

Pickworth, C. L., S. C. Loerch, and F. L. Fluharty. 2008. Effect of vitamin A on finishing beef cattle.

Reveneau, C., S. K. R. Karnati, C. V. D. M. Ribeiro, E. R. Oelker, B. Mathew, D. R. Bae, C. M. Drow, and J. L. Firkins. 2007. Interactions of unsaturated fat or coconut oil with Rumensin on milk fat production might be mediated through inhibition of specific protozoal genera.

Roe, Brian, and Tim Haab. 2007. Using biomedical technologies to inform economic modeling: Challenges and opportunities for improving the descriptive and positive analysis of environmental policies.

Sweeney, C. F., L. E. Rodriguez-Saona, and M. M. Giusti. 2009. Rapid determination of Concord grape content in commercial grape juices.

Tian, M., M. L. Asp, A. A. Wendel, and M. A. Belury. Dysregulation of lipid metabolism in cardiac muscle of mice with cachexia. FASEB J 2008;22:#147.5.

Wang, H. H. 2007. Antibiotic resistant commensals in the food chain and potential impacts.

Article, Peer Reviewed

Adua, Lazarus, and Jeff S. Sharp. Examining survey participation and data quality: The significance of topic salience and incentives." *Survey Methodology* (in press).

Asp, M. L., M. Tian, A. A. Wendel, and M. A. Belury. 2009. Evidence for the early involvement of insulin resistance in the development of cachexia in tumor-bearing mice.

Asp, M. L., M. Tian, A. A. Wendel, and M. A. Belury. Insulin resistance occurs early in cancer cachexia. *Int J Cancer* (in press).

Barden, C. A., H. L. Chandler, P. Lu, et al. 2008. Effect of grape polyphenols on oxidative stress in canine lens epithelial cells.

Bardhan, S., M. Watson, and W. A. Dick. 2008. Plant growth response in experimental soiless mixes prepared from coal combustion products and organic waste material.

Cattaneo, A. A., R. Wilson, D. Doohan, and J. T. LeJeune. 2009. Bovine veterinarians' knowledge, beliefs, and practices regarding antibiotic resistance on Ohio dairy farms.

Chen, G., N. A. Kocaoglu-Vurma, W. J. Harper, and L. E. Rodriguez-Saona. 2009. Application of infrared microspectroscopy and multivariate analysis for monitoring the effect of adjunct cultures during Swiss cheese ripening.

Deol, Y. S., S. K. Grewal, L. Canas, M. Yenik, and P. S. Grewal. 2006. An assessment of entomopathogenic nematode delivery through a commercial potting medium and a garden soil.

Gangaiah, Dharanesh, Issmat I. Kassem, Zhe Liu, and Gireesh Rajashekara. 2009. Polyphosphate Kinase 1 is Important for VBNC Formation, Natural Transformation and Antimicrobial Resistance in *Campylobacter jejuni*.

Gorocica-Buenfil, M. A., F. L. Fluharty, T. Bohn, S. J. Schwartz, and S. C. Loerch. 2007. Effect of low vitamin A diets with high-moisture- or dry-corn on marbling and adipose tissue fatty acid composition of beef steers.

Gorocica-Buenfil, M. A., F. L. Fluharty, and S. C. Loerch. 2008. Effect of vitamin A restriction on carcass characteristics and immune status of feedlot beef steers.

Gorocica-Buenfil, M. A., F. L. Fluharty, C. K. Reynolds, and S. C. Loerch. 2007. Effect of dietary vitamin concentration and roasted soybean inclusion on marbling, adipose cellularity, and fatty acid composition of beef.

Gorocica-Buenfil, M. A., F. L. Fluharty, C. K. Reynolds, and S. C. Loerch. 2007. Effect of vitamin A restriction on marbling and conjugated linoleic acid content in Holstein steers.

Jones, M. L. 2008. Ethylene signaling is required for pollination-accelerated corolla senescence in petunias.

Karnati, S. K. R., J. T. Sylvester, C. V. D. M. Ribeiro, L. E. Gilligan, and J. L. Firkins. 2009. Investigating unsaturated fat, monensin, or bromoethanesulfonate in continuous cultures retaining ruminal protozoa. I. Fermentation, biohydrogenation, and microbial protein synthesis.

Karnati, S. K. R., Z. Yu, and J. L. Firkins. 2009. Investigating unsaturated fat, monensin, or bromoethanesulfonate in continuous cultures retaining ruminal protozoa. II. Interaction of treatment and presence of protozoa on prokaryotic communities.

Kim, M. G., X. Geng, S. Y. Lee, and D. Mackey. 2009. The *Pseudomonas syringae* Type III Effector AvrRpm1 Induces Significant Defenses by Activating the Arabidopsis NB-LRR-protein RPS2.

Kim, M. G., S. Y. Kim, W. Y. Kim, D. Mackey, and S. Y. Lee. 2008. Responses of Arabidopsis thaliana to Challenge by *Pseudomonas syringae*.

Kleinhenz, M. D., D. M. Francis, M. Young, T. Aldrich, and S. Walker. 2008. Performance of conventionally and organically grown grafted 'Celebrity' tomato in Ohio in 2008. *In*: Midwest Vegetable Variety Trial Report for 2008, Bulletin No. B18048, Dept. of Horticulture, Office of Agr Res Progs, Purdue Univ., West Lafayette, IN.

Kleinhenz, M. 2008. Optimize production: Using high tunnels and grafted plants may give some growers a competitive edge. *American Vegetable Grower*. December 2008. p. 12, 14.

Kleinhenz, M.D. 2008. Tomato grafting: Its status and potential. *Ohio's Country Journal,* August 2008, p. 19. Also posted at *Ohio's Country Journal* web site (http://www.ocj.com/PDF/R.11.CropsAug2008.pdf).

Long, A. C., A. Agler, C. M. H. Colitz, et al. 2009. Isolation and characterization of primary canine lens epithelial cells.

Long, A. C., C. M. H. Colitz, J. A. Bomser. 2007. Regulation of gap junction intercellular communication in primary canine lens epithelial cells: Role of protein kinase C.

Manuzon, M. Y., S. E. Hanna, H. Luo, W. J. Harper, and H. H. Wang. 2007. Development of a real-time PCR method to quantify antibiotic resistance gene pool in retail dairy products.

Oelker, E. R., C. Reveneau, and J. L. Firkins. 2009. Interaction of molasses and monensin in alfalfa hay- or corn silage-based diets on rumen fermentation, total tract digestibility and milk production by Holstein cows.

Rae, R. G., C. Verdun, P. S. Grewal, J. S. Robertson, and M. J. Wilson. 2007. Biological Control of Terrestrial Molluscs Using *Phasmarhabditis hermaphrodita*: Progress and Prospects.

Rajashekara, G., M. Drozd, D. Gangaiah, B. Jeon, Z. Liu, and Q. Zhang. 2009. Functional Characterization of the Twin-arginine Translocation System in *Campylobacter jejuni*.

Roe, Brian E., Timothy Haab, David Beversdorf, Howard Gu, and Michael Tilley. 2009. Risk-Attitude Selection Bias in Subject Pools for Experiments Involving Neuroimaging and Blood Samples.

Roe, B. E., M. R. Tilley, H. H. Gu, D. Q. Beversdorf, W. Sadee, T. C. Haab, and A. C. Papp. 2009. Financial and Psychological Risk Attitudes Associated with Two Single Nucleotide Polymorphisms in the Nicotine Receptor (CHRNA4) Gene.

Tubail, K., L. Chen, F. C. Michel, H. M. Keener, M. Klingman, W. Dick, and D. Kost. 2008. Gypsum additions reduce ammonia nitrogen losses during composting of dairy manure and biosolids.

Wilson, R. S., N. Hooker, M. A. Tucker, J. LeJeune, and D. Doohan. 2009. Targeting the farmer decision making process: A pathway to increased adoption of integrated weed management.

Wilson, R. S., M. A. Tucker, N. H. Hooker, J. T. LeJeune, and D. Doohan. 2008. Perceptions and beliefs about weed management: Perspectives of Ohio grain and produce farmers.

Book Chapter

Chen, S., M. Gowda, R. C. Venu, P. Songkumarn, C. H. Park, M. Bellizzi, D. Ebbole, and G. L. Wang. 2009. Isolation and functional analysis of putative effectors from *M. oryzae* using integrated genomic approaches.

Geng, X., and D. Mackey. 2010. Dose response to and systemic movement of dexamethasone in the GVG inducible transgene system in Arabidopsis.

Jones, M. L., A. D. Stead, and D. G. Clark. 2009. Petunia flower senescence.

Kim, M. G., and D. Mackey. 2008. Measuring cell wall-based defenses and their effect on bacterial growth in Arabidopsis.

Wilson, M. J., and P. S. Grewal. 2005. Biology, production, and formulation of slug-parasitic nematodes.

Student Funding

Adugu, Emmanuel K. PhD. Factors associated with engagement in political consumption Columbus, Ohio. Ohio State University. Dissertation, Rural Sociology Graduate Program. 2008.

Bai, Shuangyi. PhD. Identification and Characterization of Senescence-Associated Proteins in Petunia Corollas. Spring 2008.

Campbell, Jenny. Masters. The Role of Arachidonic and Docosahexaenoic Acid in Hepatic Fuel Utilization During the Perinatal Period of Pigs. Winter 2009.

Correa, V. PhD. Molecular Mediation of Pathogen-Insect Vector Interactions in Maize Disease Expression. Summer 2010.

da Cunha, Luis. PhD. Functional Characterization of the Arabidopsis Protein RIN4, A Negative Regulator of Plant Resistance Against.

Deemer, Danielle. Masters. Public attitudes toward farm animal well-being: The significance of religion and political affiliation. Rural Sociology Graduate Program. 2009.

Deol, Yadwinder. Masters. Development of a Novel Delivery System for Entomopathogenic Nematodes. Summer 2006.

Holmes, Kathryn L. PhD. The Ecology and Management of Headwater Riparian Areas in the Erie Gorges Ecoregion of Northeastern Ohio. Summer 2008.

Hwang, Yun Jae. PhD. Three Essays on Risk Perception. Winter 2006.

Karnati, S. K. R. PhD. Application of Molecular Techniques to Assess Changes in Ruminal Microbial Populations and Protozoal Generation Time in Cows and Continuous Culture.

Long, Amy. PhD. Stress-Induced Lens Epithelial Cell Signaling: Mechanisms of Action and Antioxidant Protection. Fall 2007.

Oelker, E. R. Masters. Effects of Molasses and Monensin in Diets Based on Alfalfa Hay or Corn Silage on Rumen Fermentation, Total Tract Digestibility and Milk Production in Holstein.

Prabhakar, Veena. Masters. Profiling of Cheese Bacterial Cultures by Infrared Spectroscopy. Fall 2009.

Reveneau, C. PhD. Dietary Source and Availability of Fatty Acids to Manipulate Ruminal Protozoa, Metabolism of Fat, and Milk Fatty Acid Profile in Lactating Dairy Cows. Winter 2008.

Soledad Benitez Ponce, Maria. PhD. Applied T-RFLP Analyses for the Identification and Characterization of Microbial Populations.

Subramanian, Anand. PhD. Monitoring Flavor Quality, Composition and Ripening Changes of Cheddar Cheese Using Fourier-Transform Infrared Spectroscopy. Spring 2009.

Sweeney, Christian. Masters. Characterization and Discrimination of Grape Juices by Infrared Spectroscopy. Spring 2009.

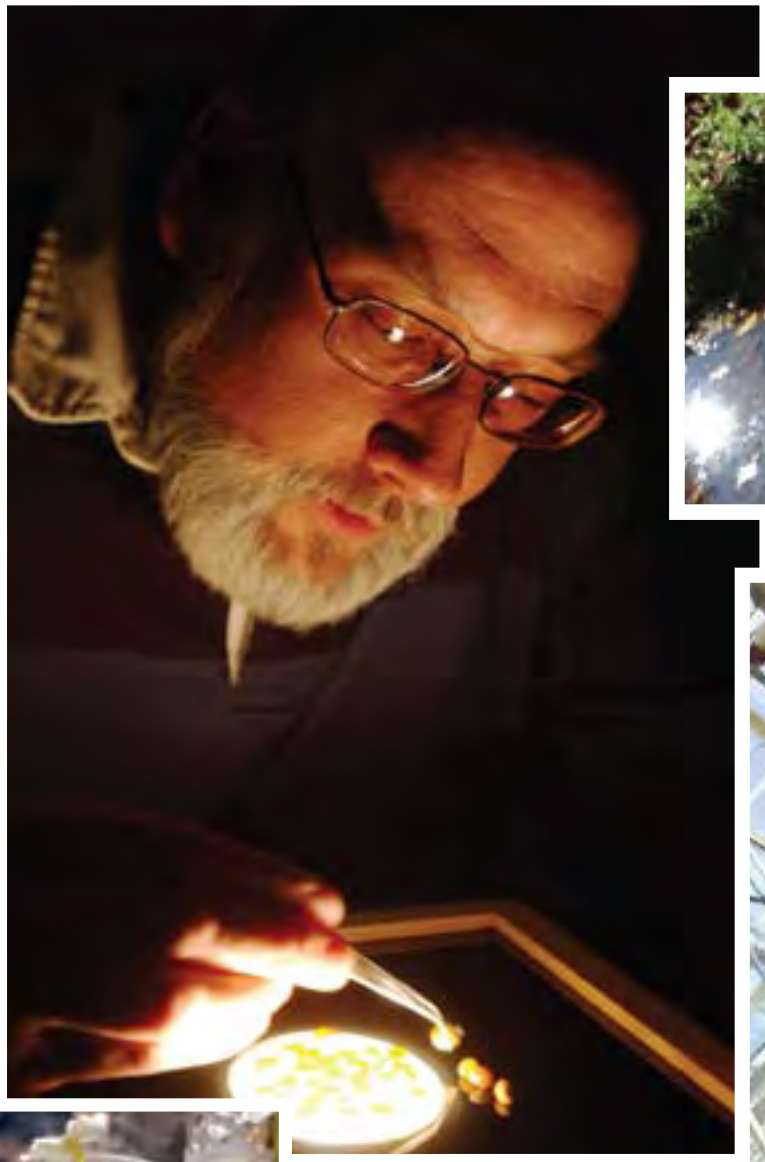
Whitacre, Shane. Masters. Soil Controls on Arsenic Bioaccessibility: Arsenic Fractions and Soil Properties. Spring 2009.

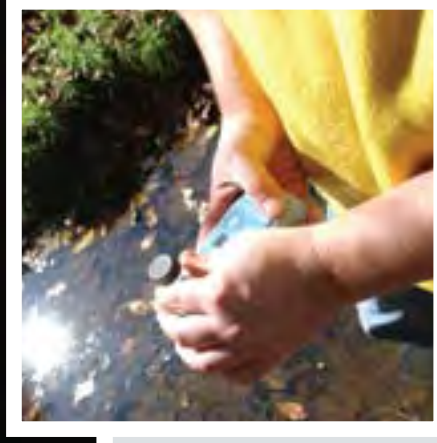
Zhu, Shudan. PhD. Regulation of RIN4 Function via Phosphorylation. Unknown, 2012.

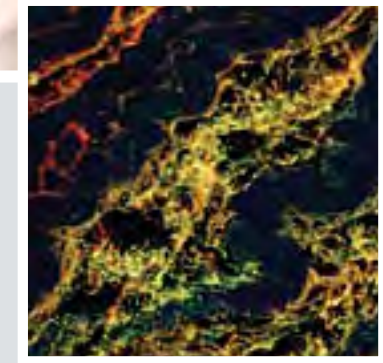
OSU students
Natalie Bumgarner (Horticulture and Crop Science)
Chunxue Cao (Plant Pathology)

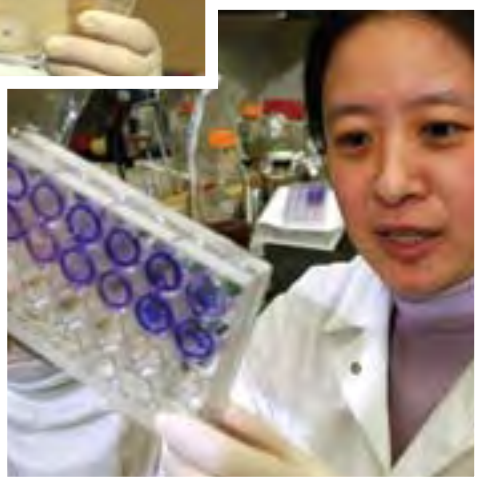
Undergraduate Students
Sarah Vogele
Bethany Caldwell

Visiting Scientists
Nancy Huarachi, Bolivia
Mohamad Abu Masud, Bangladesh









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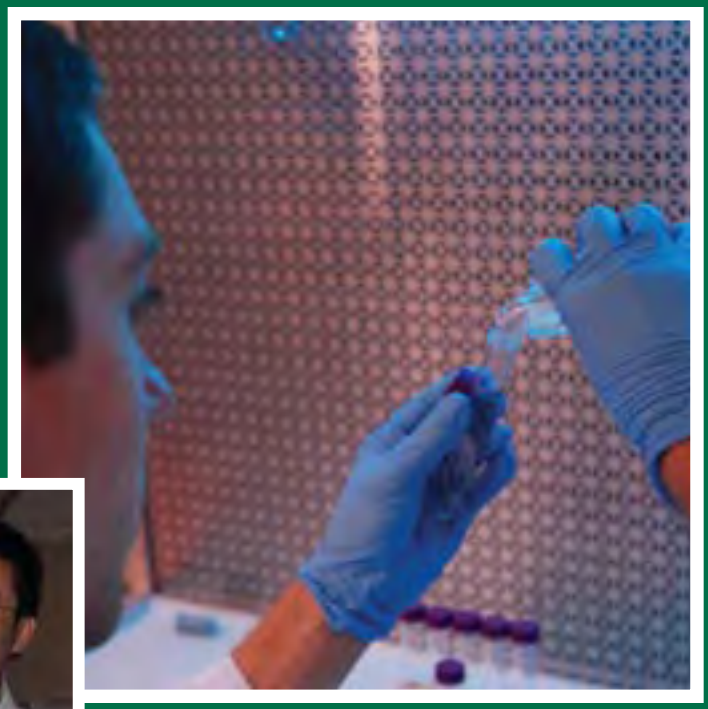

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